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PRELIMINARY NOTES ON SOME AMERICAN CHALICOTHERES[1]

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COMPARATIVELY little is known of the American forms of the Chalicotherioidea,— an extinct family of mammals. Professors Marsh,[2] Cope,[3] Scott,[4] and Osborn[5] have from time to time published brief accounts of the few fragments available, but nothing comprehensive on the osteological structure of these unique animals has been accessible in America until quite recently.

A short time ago Dr. W. J. Holland, Director of the Carnegie Museum, gave the writer permission to submit to the Seventh International Zoological Congress some brief notes on the splendidly preserved remains of *Moropus elatus* Marsh which were secured by the Carnegie Museum from the Agate Spring Fossil Quarry in Sioux County, Nebraska.

This important fossil quarry has yielded much material which is now being prepared for study and publication. The quarry is located in the valley of the Niobrara River in the Lower Harrison horizon, and was evidently the bed of a stream, or perhaps the shore of a small lake, during a portion of the Miocene time. The bones were imbedded in a comparatively thin stratum of soft sandstone which was quarried out in large blocks. These were properly

[1] Read before the Seventh International Zoological Congress, Boston, Mass., August 21st, 1907.

[2] Am. Jour. Science, Vol. XIV, pp. 249–251, 1877.

[3] American Naturalist, Vol. XXIII, pp. 149–151, 1889.

[4] American Naturalist, Vol. XXVII, pp. 659–662, 1893.

[5] Bull. Mus. Comp. Zool., Vol. XX, pp. 99–100, 1890.

labeled with reference to their position in the quarry, in order to trace the different skeletal remains which may continue from one block to another. In working out this material, we find that there are parts of skeletons which are articulated and associated.

As there has been doubt among palaeontologists regarding Professor Marsh's genus Moropus, I decided to present the figures of some casts (Figs. 1–11). These were made, by permission of Professor Schuchert, from the types which were described as bones of edentates by Marsh. By permission of the Authorities of Yale Museum, these types are here illustrated for the first time, and they quite correctly represent the specimens. With the types are associated such specimens of Moropus from the Agate Spring Quarry (Figs. 12–20) as will at once show the characters which are identical.

EXPLANATION OF FIGURES 1–20

All figures ¼ natural size

Type of *Moropus distans* Marsh. From the John Day Formation, Oregon.

FIG. 1.— Dorsal view of first and portion of second co-ossified phalanges.
FIG. 2.— Proximal articular view of the cuboid.
FIG. 3.— Dorsal view of a second phalanx.
FIG. 4.— Plantar view of the same phalanx.

Type of *Moropus senex* Marsh. From the John Day Formation, Oregon.

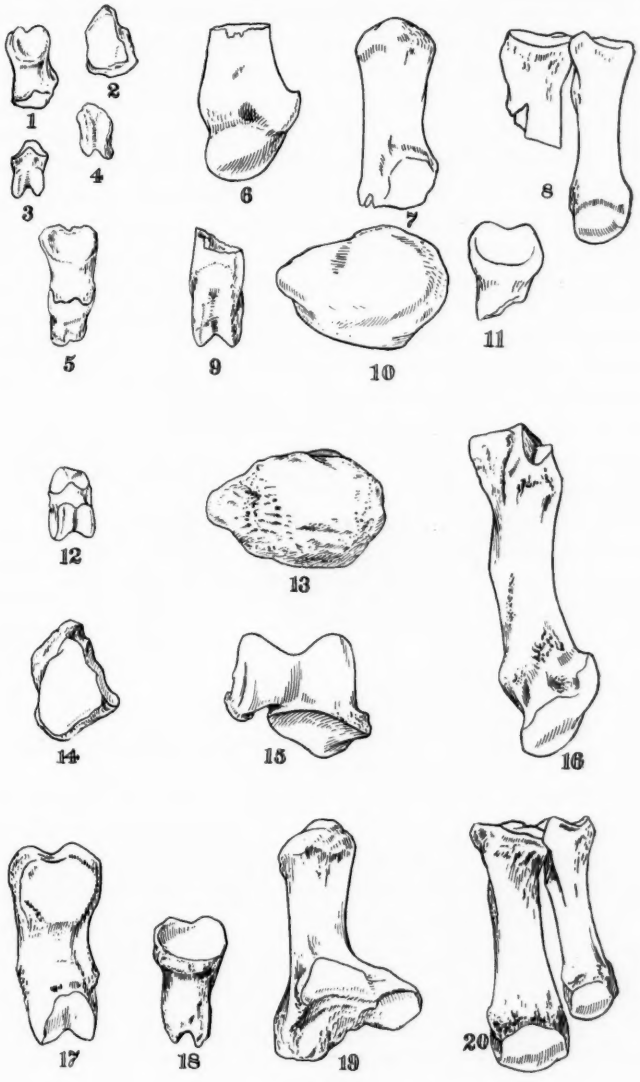
FIG. 5. —Dorsal view of the first and portion of second co-ossified phalanges.

Type of *Moropus elatus* Marsh. From the Miocene of Nebraska.

FIG. 6.— Dorsal view of distal end of second metacarpal.
FIG. 7.— Tuberosity of calcaneum.
FIG. 8.— Dorsal view of metatarsals II and III.
FIG. 9.— Dorsal view of co-ossified first and second phalanges.
FIG. 10.— Dorsal view of patella.
FIG. 11.— Dorsal view showing the proximal end of a first phalanx.

Material of *Moropus elatus* Marsh, from the Agate Spring Fossil Quarry. Miocene of Nebraska.

FIG. 12.— Dorsal view of a second phalanx.
FIG. 13.— Dorsal view of patella.
FIG. 14.— Dorsal view of second metacarpal.
FIG. 15.— Proximal articular view of the cuboid.
FIG. 16.— An oblique view of the astragalus.
FIG. 17.— Dorsal view of co-ossified first and second phalanges.
FIG. 18.— Dorsal view of a first phalanx.
FIG. 19.— Front view of calcaneum.
FIG. 20.— Dorsal view of metatarsals II and III.



FIGURES 1–20.

The skeletal structure of Moropus is a unique combination of characters. The phalanges are highly modified, terminating in cleft ungues which were, no doubt, covered by heavy claws; otherwise the skeleton is distinctively of an ungulate type, most closely resembling the Perissodactyla. The fore limbs are longer than the hind limbs; they, together with the clawed feet, must have given to the animal a very peculiar appearance. Some species are as large as an African rhinoceros, or even larger. In the *American Naturalist*, March 1889, p. 151, Professor Cope established a separate order (Ancylopoda) for these different forms, which in the Miocene time extended over Europe, Asia, and America. After a study of the recently discovered remains, which include nearly all parts of the skeleton, the present writer would place Moropus as a distinct genus, in the Chalicotherioidea which, he is inclined to believe, should be considered as an aberrant superfamily of the Perissodactyla, as it was provisionally regarded by Professor Osborn[1] in a recent publication.

At this point it is thought best to give a short description of a few characteristic features in the osteology of the skeleton of Moropus as we know it from the material in the Carnegie Museum at Pittsburgh.

THE SKULL

No. 1707 Carnegie Museum Catalogue of Vertebrate Fossils.

The skull, on which these brief notes are based, was found in the Agate Spring Fossil Quarry by Mr. W. H. Utterback. It is that of a young individual, which, when found, was disarticulated. We have not, as yet, found a perfect skull of Moropus,[2] but aside from this our material is quite complete. The parts, associated in this skull, but which may not belong to the same individual, are the occipital condyle, the basioccipital (No. 1707 A), and the lower

[1] The Extinct Rhinoceroses. Memoirs of the American Museum of Natural History, Vol. I, Part III, p. 79, 1898.

[2] Professor Barbour of the Nebraska State University, Lincoln, Neb., was fortunate in securing a fairly good skull of Moropus from the same stratum on an adjoining hill.

jaws (No. 1711). The latter parts are here inserted (Fig. 21) in order to give a better idea of the cranium. Since no foot bones were found in connection with these skulls, a positive identification of the species as *elatus* Marsh can not be made.

The skull of Moropus, as a whole, is of the long and narrow type (Figs. 22 and 23) and is in a general way similar to that of Macrotherium of Europe.[1] In this young specimen from Nebraska there is no sagittal crest. The braincase is sub-ovate in form and of fairly large size. The parietal is present on one side and is of

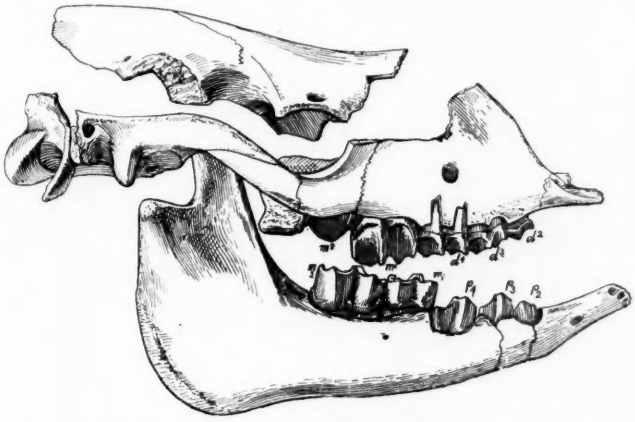


FIG. 21. — *Moropus elatus?* Marsh. ¼ natural size. Side view of the skull of a young individual, No. 1707; side view of the lower jaw of a young individual, No. 1711.

considerable antero-posterior diameter. Superiorly the bone is very gently convex from before backward, and the two parietals together meet the frontals in a broadly open U-shaped outline. The frontal is quite broad over the orbit as in Meniscotherium from the lower Wasatch, and the orbital border is heavy and somewhat overhanging with a large foramen near the margin. This is well shown in the illustrations (Figs. 21 and 22). The supra-temporal ridge is very faint; this may be due to the immaturity of

[1] See Professor Depèret's Memoir "Faune de Mammifères Miocenes de la Greve-St. Alban"; Arch. Muse. d'Hist. Nat. d'Lyon V, Pl. II., 1892.

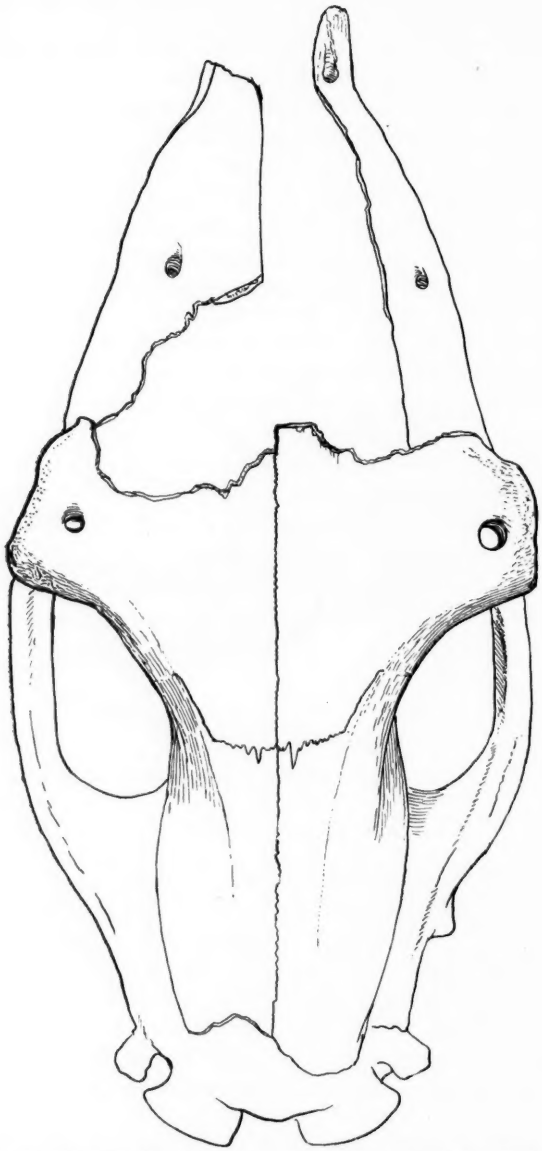


FIG. 22. — *Moropus elatus?* Marsh. ⅓ natural size. Top view of the skull of a young individual, No. 1707.

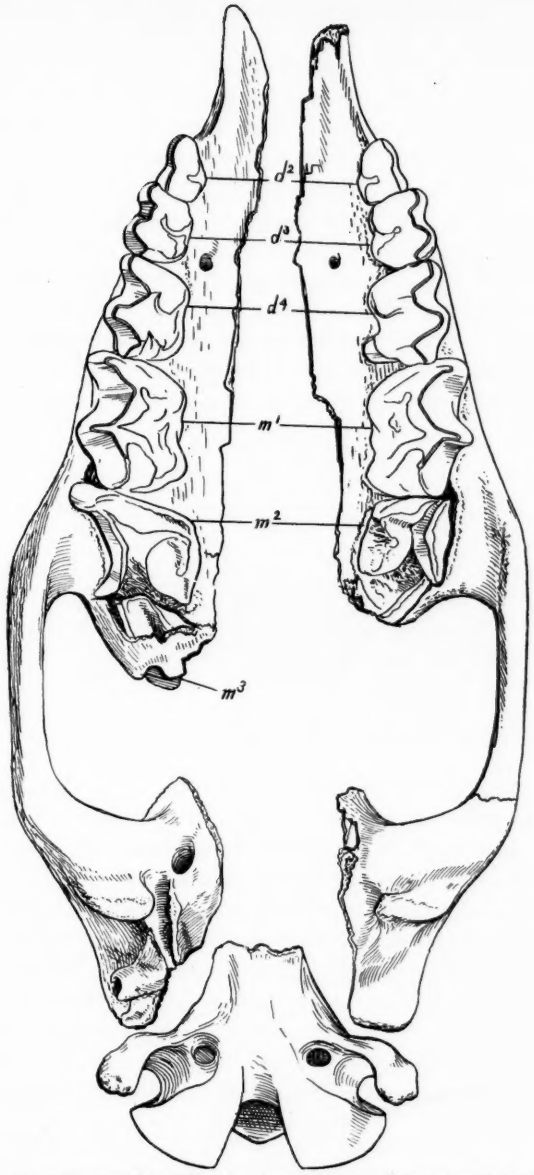


FIG. 23. — *Moropus elatus* ? Marsh. ½ natural size. Palate view of the skull of a young individual, No. 1707.

the specimen, but it continues from the inion to the orbital border. The orbit is located well forward on the skull and is open posteriorly in a similar manner to that of the known European forms. The maxillary bone is high and the maxillo-premaxillary suture ascends rapidly. The premaxillary bone of Moropus is not known, but I judge that it attained a considerable length and was perhaps edentulous or retained small incisors.[1] The infra-orbital foramen is large and is placed above D^4. The jugal is small with a delicate zygomatic process. The zygomatic process of the squamosal is equally small so that the arch is rather more delicate than that represented in the European genus. The glenoid process is of fairly large size and the space between the latter process and

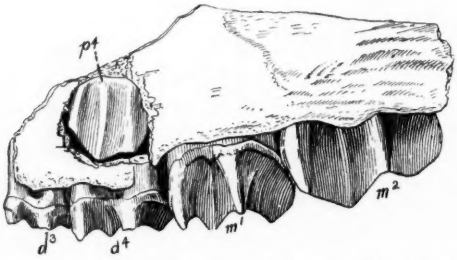


FIG. 24. — *Moropus elatus?* Marsh. ½ natural size. Side view of maxilla of a young individual, No. 1709, showing p^4 in an unerupted stage.

the paroccipital is occupied by the external ear and the mastoid in much the same way as in the recent horse. The external auditory meatus is of fairly large size and is directed outward and very slightly upward, not unlike that in Equus. Whether or not there was a tympanic bulla cannot be determined from the material at hand. The occipital condyle is large and there is a slight accessory facet on the basioccipital. The condylar foramen is of large size and is situated immediately back of the paroccipital process at its internal angle. The latter process is much elongated and suggests that of the recent horse. In fact a number of osteological features of Moropus suggest characters in the equine family of the Perissodactyla.

[1] Lower jaws of adults with incisors in place always show wear on the median pair, while the lateral teeth are almost entirely unworn.

The molar-premolar series of Moropus has a general similarity to that of the Titanotheres, but a brief comparison of the more important differences is thought to be of interest in this connection. The external walls of the upper premolars of Titanotherium are excavated, forming a transverse median valley on the grinding face of the teeth, while in Moropus the walls are highest in the middle, and this portion of the tooth is not divided by a transverse valley. The internal cusps of all the upper premolars in Titanotherium have a tendency to become divided so as to form a larger anterior and a smaller posterior tubercle. In Moropus the single tubercle is crescentic, especially on P^1. On the molars of Titanotherium there are two distinct internal tubercles, while in

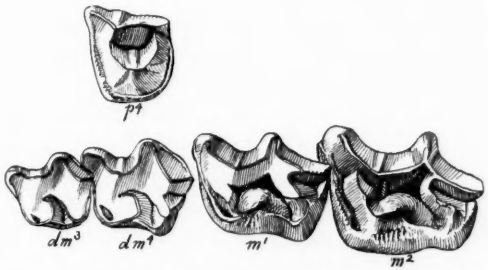


FIG. 25. — *Moropus elatus?* Marsh. ½ natural size. Crown view of the same specimen as Fig. 24.

Moropus there is only one tubercle and a transverse cutting lobe on the posterior internal angle of the tooth. This transverse lobe which unites with the external part of the tooth has apparently taken the place of the posterior internal tubercle (hypocone) of Titanotherium and is similar to that of Meniscotherium as was pointed out by Professor Osborn in comparing the latter with the known genera of the Chalicotherioidea.[1] The upper molars in Moropus are relatively longer and narrower than in the Titanotheridae; they are also longer and narrower than the upper molars of the best known forms of Chalicotherioidea in Europe and Asia.[2]

[1] American Naturalist, Vol. XXVII., p. 127. February, 1893.

[2] On Plate III., figs. 3, 4, and 5 in Depèret's Memoir, l. c., are figures of upper molars which more nearly agree in diameter with those of Moropus.

The close similarity of the lower molar-premolar series of Chalicotherioidea to that of Titanotherium and Palaeosyops is well known. As in the European forms, the present genus has also the premolars reduced to three teeth in both upper and lower jaws, while in the Titanotheridae there are four. P_2 in Moropus is quite simple in structure, while P_3 is more nearly like P_2 in Titanotherium. The internal tubercle of P_4 in Moropus is somewhat heavier than that in Titanotherium, otherwise the tooth suggests that of the latter genus. M_1 and M_2 in Moropus are similar to those in Titanotherium. M_3 in the latter genus has a prominent posterior heel which is lacking in Moropus. This third lobe of M_3 is also lacking in the Wasatch genus Meniscotherium.

The deciduous upper molars (No. 1709) in Moropus are more nearly molariform than are the permanent premolar series.[1] Deciduous M^4 (d^4 and dm^4 in Figs. 24 and 25 respectively) may very easily be taken for the permanent M^1, if extreme care is not exercised in the study of the dentition. The permanent P^4 cuts the alveolar border shortly after permanent M^2 is entirely erupted.

Measurements of the Skull

	mm.
Diameter of skull, from external auditory meatus to extreme anterior point of maxillary,	305
Diameter of skull, from external auditory meatus to anterior border of the orbit,	160
Diameter of skull, from anterior border of the orbit to extreme anterior point of the maxillary,	150
Transverse diameter of the frontals over the orbits,	160

Vertebral Column

No. 1604, Carnegie Mus. Cat. Vert. Foss.

The vertebral formula of Moropus is for the most part based on a skeleton, the bones of which were found disarticulated, but

[1] Hatcher has pointed out this same characteristic feature in Titanotherium, Annals Carnegie Museum, Vol. I, pp. 259–260, 1901.

quite close together, in the Agate Spring Fossil Quarry. As the vertebrae are found to fit one another in a quite perfect manner, there is very little doubt that the cervicals and the dorsals are, excepting the eighth and eleventh dorsals which are evidently lost, correctly represented by this specimen. We found seven cervicals, thirteen dorsals, and three anterior lumbars belonging to the same individual. The cervical and dorsal regions are apparently quite complete, while three lumbars are lacking, but judging from other individuals found in the quarry the complete number in the lumbar series was six. There was no sacrum with this individual, but we know that there are four sacral vertebrae. The caudal region is not fully known, but I judge that it attained a length about equal to that in the rhinoceroses generally.

The Cervical Vertebrae.— For an animal with a comparatively small head, the cervical vertebrae of Moropus are quite robust. The general structure of the cervical region suggests that of the recent horse. With the exception of the greater angularity of the transverse process, the different position of the arterial canal and the open atlanteal notch, the atlas might be taken for that of a large specimen of *Equus caballus*. The axis is still more suggestive of the horse, but the inferior keel is larger and the neural spine higher,[1] more overhanging in front, and somewhat more robust. The articulation for the atlas has the same spout-shaped extension anteriorly, but with the median protuberance relatively much enlarged, forming a curious knob which doubtless represents the primitive odontoid process. With the exception of the more produced condition of the centra posteriorly, the more broadly developed hypapophysial keels inferiorly, the higher neural spines, the relatively heavier neural arches, and the larger zygapophysial faces, the general make-up of the cervicals back of the axis in Moropus is similar to that in Equus. There is no vertebrarterial canal in the seventh cervical. That the animal could easily reach the ground with his head is very evident from similarities of the cervical articulations to those of *Equus caballus*.

[1] The axis of Macrotherium of Europe is described and figured by Professor Depèret and presents the same general characters as that in the American species. The neural spine of the former is relatively higher than that in the latter species.

The Dorsal Vertebrae. — Although the number of the dorsal vertebrae in Moropus is less (there are thirteen present and two — the eighth and eleventh dorsals — lost in the specimen under consideration) they are perhaps more suggestive of those of Aceratheria or Metamynodon from the Oligocene than those of the horse. The first dorsal in Moropus has a relatively longer neural spine than that in the horse, and in this respect it resembles more nearly some of the more primitive perissodactyls. The seventh, ninth, and tenth dorsal vertebrae in No. 1604 have complete neural spines. It is seen that the neural spines of the latter vertebrae are relatively shorter and have a more backward slope than in the horse. The thirteenth and fourteenth dorsals have wide neural spines, which are constricted antero-posteriorly at their bases. In these vertebrae there are strong metapophyses. The fifteenth dorsal vertebra in Moropus is quite characteristic and is different from all preceding vertebrae. The posterior zygapophyses have already become convex in the same manner as in the lumbar region.

The transverse process is pierced at the base by a large foramen and is further characterized by having a superior and an inferior division. The superior division of the transverse process is the larger of the two and is directed outward, while the smaller inferior division has a downward and backward direction. Between the two divisions there is a deeply emarginated area, which is converted into a thin bony bridge bounding the foramen referred to above. On this and the succeeding vertebra (the first lumbar) the metapophyses are the heaviest and they rapidly decrease in size on the succeeding lumbars, while on the dorsals there is still a very small metapophysial protuberance left on the seventh vertebra.

Only the first three lumbar vertebrae are present in No. 1604, the specimen under consideration, but from other material found in the quarry it is quite certain that the complete series is six. The three lumbars present are very robust, and possess broad neural spines which are enlarged and rugose at the superior end. The zygapophyses are simply convex and concave with no additional superior articular faces. The transverse processes are only moderately developed.

The Sacrum. — The sacrum (No. 1706) is composed of four

vertebrae well co-ossified, with high and backwardly sloping neural spines which are all co-ossified and increase in robustness from before backward. The neurapophysis of the first sacral is very heavy and supports the greatest weight of the ilium, though the succeeding three sacrals share in the support as there is a rugose attachment for the ilium throughout the entire length of the sides of the sacrum.

A number of caudals of considerable length, found in the quarry, may belong to Moropus but this is not fully determined at present.

In No. 1604, Car. Mus. Cat. Vert. Foss., the best preserved skeleton of Moropus, there are present fifteen ribs of the right and fourteen of the left side; the first rib of the left side is lost. The ribs are of moderate length, but robust, and the anterior ones are expanded at the lower ends, indicating a heavy sternal attachment.

Limbs

Nos. 1604; 1706; 1710; Carnegie Mus. Cat. Vert. Foss.

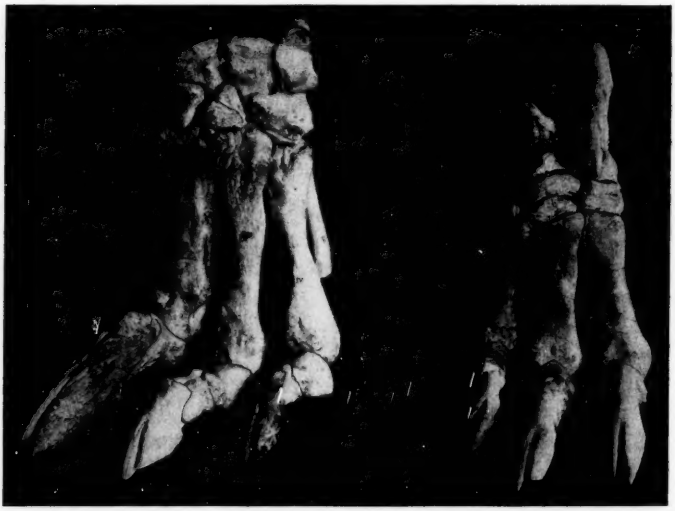
The structure of the fore and hind limbs of Moropus was briefly described in a former paper,[1] and I wish here only to call attention to a few of the more important features which are shown in the splendidly preserved material in the Carnegie Museum.

The Fore Limb.— The scapula of Moropus is quite large. It is plainly of a perissodactyl type, and resembles most closely that of *Aceratherium tridactylum* Osborn. As in the latter genus the spine is prominent and overhangs the post-scapular fossa in a similar manner. The humerus, radius, and ulna of Moropus, as a whole, are quite like these parts in the European genera.[2] The humerus of Moropus has a heavy deltoid ridge, which extends well down on the shaft. The greater tuberosity is also quite robust and the bicipital groove is single and moderately deep, but quite broad. The distal end is much expanded transversely and suggests that of

[1] Annals Carnegie Museum, Vol. IV, No. I, pp. 60–61, 1906.

[2] In *Macrotherium grande* the fore limb is relatively longer than in Moropus according to the figures and description of Professor Depèret, "La Faune de Mammifères de la Greve-St. Alban" Pl. IV, Figs. 2 and 9.

Phenacodus from the Wasatch. The trochlea is broad with well rounded articular surfaces for the radius and ulna. The anconeal fossa is quite deep and broad, but low. In this specimen (No. 1604) the radius and ulna are entirely co-ossified. On the radius the external articular facet for the humerus is considerably larger than the internal, while on the ulna the internal articulation is very extensive. On a direct front view the head of the radius lies in front of the ulna, but immediately below the head on the external side, the shaft of the ulna again appears. The olecranon of the



A B

FIG. 26. — *Moropus elatus* Marsh. About ⅛ natural size. A, the left fore foot of skeleton No. 1604. B, the left hind foot, No. 1710, which belongs with another skeleton.

ulna is rather truncated. The distal end of the radius and ulna together have a transversely broad aspect; the carpal articulation is characteristically plain without the prominent border which separates the scaphoid and lunar facets in other Perissodactyla. The articular surface for the cuneiform on the ulna project only very slightly below the radius and form, with the lunar articulation on the radius, a continuous and gently curved surface. The suture

between the radius and ulna is, however, well indicated on the distal articulation of the bone.

The Manus.— The manus of Moropus has four digits, three of which are functional and one (the fifth) rudimentary. This rudimentary fifth metacarpal is not supported by the unciform, but articulates with the fourth metacarpal by fairly well formed facets. Mc.V [1] in No. 1700, Car. Mus. Cat. Vert. Foss., is much slenderer and attains only three-fourths the length of mc. IV. The distal trochlea of mc. V., in No. 1700 is quite imperfect and the digit had perhaps only one phalanx. The trapezium is present and articulates with mc. II, the trapezoid, and the scaphoid, but there is no indication of a first digit. The heavy protuberance on the scaphoid of Moropus which reaches over the trapezoid and articulates with the magnum may be represented by the centrale in Meniscotherium.[2] The magnum has a heavy protuberance on the anterior face which extends dorsally and forms, on the distal face, a rough articular surface for the proximal end of mc. II; on the palmar face is a short but heavy hook, and the total vertical diameter of the bone is much greater than is apparent on a direct front view of the manus. The second metacarpal, though shorter than the third and fourth, is the heaviest in the series. The third metacarpal is the longest, consequently the second and third digits in the manus of Moropus supported the greatest weight; therefore the manus is more nearly mesaxonic than was anticipated. It is different from the European genus from Sansan in which mc. IV is the longest.

In the manus of Moropus, the first and second phalanges of the second digit are co-ossified, an important character which Professor Marsh luckily discovered in three different individuals. This now proves to be of perhaps a family importance.[3] The ungual phalanx of the second digit is much larger than those on the third

[1] In No. 1604 the fifth metacarpal is wanting, but the articular facets of mc. IV plainly indicate its presence.

[2] Amer. Jour. Science, Vol. XLIII, p. 447, 1892. (*Hyracops socialis* Marsh.)

[3] From Cope's statement in the American Naturalist, March, 1889, Vol. XXIII, p. 153, I infer that Lydekker has said that "Ancylotherium" Gaudry has the first and second phalanx co-ossified. Good casts of the latter genus are exhibited in the American Museum of Natural History which confirm this statement.

and fourth, and is more conspicuous than that of the European form from Sansan. In Moropus as in "Ancylotherium" this large ungual has a comparatively limited dorsal flexure, as there is a shoulder near the dorsal border of the distal trochlea of this duplex bone and a corresponding buttress on the articulation of the terminal phalanx; thus furnishing additional strength in the use of this digit.

Hind Limb.— The pelvis (No. 1706) of Moropus may be regarded as long and narrow. In comparing it with that of Perissodactyla generally it is relatively longer in the region back of the acetabulum, which feature is artiodactyl rather than perissodactyl. Altogether, the pelvis of Moropus most nearly agrees with that of *Aceratherium tridactylum*. As in the latter genus, the neck of the ilium is long with a rapid expansion near the supra-iliac border, but this border is less emarginated than in Aceratherium. In Moropus the acetabulum is deep, and the pit for the round ligament is of large size and is confined to the region back of the median line. The obturator foramen is ovate in outline and of medium large size. The pubic symphysis is quite strong anteriorly, but in No. 1706, Carnegie Museum Cat. Vert., Foss., the ischium diverges outwardly more than is usual in other specimens.[1] As stated elsewhere, the femur has a strong third trochanter, which is located above the middle of the shaft. The bone as a whole resembles that of Titanotherium, but is relatively heavier and shorter. The tibia is short and heavy; it is about four-fifths the length of the femur. The articular facets for the femur are divided by a prominent spine, the cnemial keel is heavy and extends well down on the shaft, and the distal trochlea is characteristically rhinocerotic. The fibula is complete, but its shaft is comparatively delicate and has an even curvature from above downward so that it lies close to the shaft of the tibia throughout; the distal end extends below the external articular facet of the tibia and articulates with the astragalus, but does not always touch the calcaneum.[2]

[1] The peduncle of the pubis in this specimen was badly crushed on one side and partly lost on the opposite side which may, in part at least, account for this difference.

[2] Some specimens have a minute articular facet for the fibula on the calcaneum.

The Pes. — In a general way the tarsus (No. 1710) in Moropus is much like that of the Rhinocerotidae. There are, however, many differences viz: the navicular is supported entirely by the astragalus and the cuboid by the calcaneum as in Meniscotherium. The trochlea of the astragalus is somewhat more deeply grooved, the internal and external condyles are more even in size and the external condyle is not interrupted as in Titanotherium, but continues below the articular facet for the navicular. The pes is tridactyl; there is no indication of lateral digits. The second metatarsal is shorter and also somewhat lighter than the third and fourth which are of equal size. The articulation for the proximal phalanx is confined almost entirely to the dorsal face of the bone, while on the plantar face are deep, broad grooves, which are divided by heavy keels. The sesamoids are very heavy and in some cases they are co-ossified, forming a broad open groove for the tendons. As in the fore foot the claw-bearing ungulae are deeply cleft, but of more nearly equal size.

From the study of the foot and limb structure of Moropus it is very evident that the animal was digitigrade. Professor Osborn has called attention to the fact that the European forms were "almost certainly sub-digitigrade."[1]

The remains above described (No. 1604) belong to an individual very nearly the size of *Chalicotherium goldfussi* of Europe, or the size of a small specimen of Titanotherium from the American Oligocene. Smaller remains are more common in the quarry, indicating two or more species, or a great range of individual variation. This question will be taken up in a later publication. There are perhaps twenty individuals of Moropus represented in the collection of the Carnegie Museum, which were secured in the Agate Spring Fossil Quarry.

Discussion of Affinity and Phylogeny

In *Chalicotherium goldfussi* Kaup, P^4 has the internal face of the ectoloph W-shaped and the internal tubercle of a different form and more distinctly separated than in the American genus. In the

[1] American Naturalist, Vol. XXVII, pp. 118–119, 1893.

latter, the ectoloph is simpler, and the internal tubercle is crescentic, as in the Artiodactyla, the posterior and anterior horns being firmly united with the ectoloph so as to form, of the median valley, a deep, but rapidly sloping pit. This is best seen in an unworn tooth. The upper molars, especially M^2 and M^3, in Moropus are relatively longer and narrower than in *Chalicotherium goldfussi*. The teeth in the latter species appear to have more nearly the same proportionate diameter as in the Asiatic forms *C. siense* and *C. sivalense*.[1] The more important differences between *C. sivalense* and *C. siense* as pointed out in Professor Owen's paper (l. c. pp. 431–432) are as follows: "the anterior part of the interval between the post-external (b) [b = reference to the illustrations in Owen's paper] and the postinternal (d) lobes is not closed by a ridge descending from the summit of the postexternal lobe as in *Chalicotherium sivalense*: nor does the inner side of the antexternal lobe terminate in so ridge-like a way as in *Chalicotherium sivalense*." The condition of the post-external and post-internal lobes, as well as the "ridge-like" ant-external lobe of M^3 in Moropus agree more closely with Owen's statement of *C. sivalense*; and M_3 in Moropus is very nearly of the same size and of the same general character as that in *C. goldfussi*, but the relative diameter,[2] together with other less important differences of M^3 in the European and Asiatic forms, is entirely unlike those in Moropus.[3]

Phylogeny.—The best evidence at the present time points rather towards a European[4] than an American ancestry of Moropus.

[1] Quart. Jour. Geol. Society, London, Vol. XXVI, p. 431, 1870.

[2] For measurements of upper teeth of Moropus see Annals Carnegie Museum, Vol. IV, No. I, p. 63, 1906.

[3] *Chalicotherium* (*Ancylotherium*) *pentelici*, from Pikermi, Greece, has the upper molars longer than broad, and in some other respects most nearly agree with the American form.

[4] Schizotherium Gaudry of the European Oligocene is undoubtedly an ancestor of the family. And it is likely that some European Eocene form allied to the early perissodactyls will be found to be the true ancestor. Some characters of Palaeotherium are suggestive of the Chalicotherioidea.

NOTE: While at the International Zoological Congress in Boston, I discussed the phylogeny of Chalicotherioidea with Professor Depèret who kindly added the following note: "Le plus ancien type européen des Chalicotherioidea est le Pernatherium Gervais, du calcaire de St. Ouen près Paris: il est de l'étage Bartonien, c'est à dire, à peu près du Bridger supérieur (voir Journal de Zoologie.)"

Professor Osborn has pointed out Meniscotherium from the American Eocene (Wasatch) as a possible ancestor of the Chalicotherioidea.[1] It would seem that when better specimens of *Moropus distans* are found in the John Day formation, it will become necessary to separate, generically, *Moropus elatus* from *Moropus distans*. "*Chalicotherium bilobatum*" Cope from the Oligocene of the Swift Current Creek in Canada, if correctly identified, is of course a much earlier form than *Moropus elatus* from the Miocene of Nebraska. The remains which Professor Scott reports from Montana (Deep River) may perhaps represent a transitional form between *Chalicotherium bilobatum* and *Moropus elatus*. These appear to be the evidence which we have of the presence of the chalicotheres in the American Tertiary. The little known *Spenocoelus uintensis* Osborn from the Uinta beds[2] bears some resemblance to the Chalicotherioidea as was pointed out by Osborn (l. c. p. 102), but the specimen (the posterior portion of the skull) is too imperfect for accurate comparison. While Meniscotherium may not be a true ancestor of Moropus there are in the latter certain affinities[3] to the former which are of much importance and which point to the ancestral types of the stem of the Perissodactyla.

Conclusion

The conclusions drawn from the material studied may be summed up as follows: (1) That Moropus is, excepting its unguiculate feet, essentially a perissodactyl in structure. (2) That the laterally compressed and cleft condition of the terminal phalanges is quite distinct in some of the early Perissodactyla,[4] and that by adaptation through geological ages the unguals as well as other parts of Moropus were specially modified, and should not, in the mind of

[1] American Naturalist, February, 1893, pp. 118–133.

[2] Bull. American Museum of Natural History, Vol. VII, pp. 98–102, 1895.

[3] The absence of the 3rd lobe of M_3; the 3rd trochanter of the femur, and the navicular articulating, proximally, only by the astragalus and the cuboid by the calcaneum.

[4] It is well known that Euprotogonia and some species of Phenacodus have the terminal phalanges laterally compressed, intermediate between hoofs and claws. The early horses have cleft ungues.

the writer, be regarded as of ordinal importance. (3) That Moropus is generically separable from other known forms of the Chalicotherioidea.

The illustrations are from drawings made by Sidney Prentice and photographs made by A. S. Coggeshall.

CARNEGIE MUSEUM
Pittsburgh, Pa., Aug. 2, 1907

OBSERVATIONS ON THE NATURAL HISTORY OF *POLYODON SPATHULA*

CHARLES R. STOCKARD

DURING the springs of 1904 and 1905 I visited the regions in which Polyodon attains its largest size and occurs in greatest abundance. I had been aware for several years of the existence of this fish in great numbers in the lakes bordering the lower Mississippi River. On mentioning this fact to Professor Bashford Dean, he suggested to me the desirability of visiting these lakes with the object of obtaining the eggs and developmental stages of this peculiar fish. My best thanks are due Professor Dean for this suggestion, and for placing at my disposal during both years the Dyckman Fund of the Zoological Department of Columbia University with which to defray the expenses of the trips.

Most vertebrate embryologists and particularly those familiar with the development of the ganoids will admit, I believe, that a knowledge of the development of Polyodon is greatly desired. The ganoids at present furnish an almost complete and one of the most instructive comparative embryological series. The series is incomplete, however, in that nothing is known of the development of either member of the order Selachostomi. This order comprises only two species, *Polyodon spathula* and *Psephurus gladius*. The former is found in the Mississippi River and its tributaries; the latter is known only in some of the rivers of China. Thus they have a decidedly discontinuous geographical distribution.

I spent from March first to April fifteenth, 1904, in Concordia and Catahoula Parishes of Louisiana, and from April first until May eighteenth, 1905, in Washington County, Mississippi, and on the White River in Arkansas. During this entire time efforts were made to obtain spawning Polyodon. Although unfortunately I failed to secure any of the embryonic stages, I succeeded, during the three months on the lakes and rivers where this fish is so abundant, in making many observations on its habits. The present paper contains a brief account of the behavior of the fish

during the spring and early summer seasons, and conveys some idea of the great fishing industry to which it has given rise within the past twelve years.

DESCRIPTION OF POLYODON

Polyodon in the lakes bordering the lower Mississippi River attains a much greater size than in the Ohio and upper Mississippi River region. Museum specimens and those obtained in the more northern parts of their range are rather small fishes. In the metropolis of their distribution, however, they often attain a length of almost six feet, the longest one observed by the writer being five feet and nine inches from the tip of the tail to the end of the snout. Their weight often exceeds one hundred pounds; one hundred and forty-two pounds was the maximum record in Lake Washington, Mississippi, where the fish were larger than in any other lake visited.

The shape of Polyodon is shown in the accompanying photograph, Fig. 1. Note the contrast between the slender shark-like form of the middle individual, which is a characteristic river-fish, and the heavily proportioned body of the lake-fish, on either side.

The color of these fishes during the spring differs only slightly from that at other seasons. The back and dorso-lateral portions are of a steel or slate-like hue while the ventral and ventro-lateral parts are a glistening milk-white. The fins of most mature individuals show a delicate tinge of salmon-pink, but in others the fin color partakes of the general slate-like appearance of the dorsal portions. The general color of several fishes that were obtained shortly after spawning was of a peculiar reddish tint, being several shades lighter than the normal slate color. In two "spent" individuals this color difference was detected as they swam in the water before being lifted from the seine. The anal region of these fishes showed a dark purplish-red color and their ovaries gave unmistakable evidence that spawning had occurred. No indication of sexual dimorphism could be detected, the males and females being indistinguishable in their color, size, and shape, and in the proportions of their external body appendages. A female with

her ovaries filled with eggs of the season was usually recognized by the distended condition of the abdomen and yet even this distinction was not always valid since the males when fat and in good con-

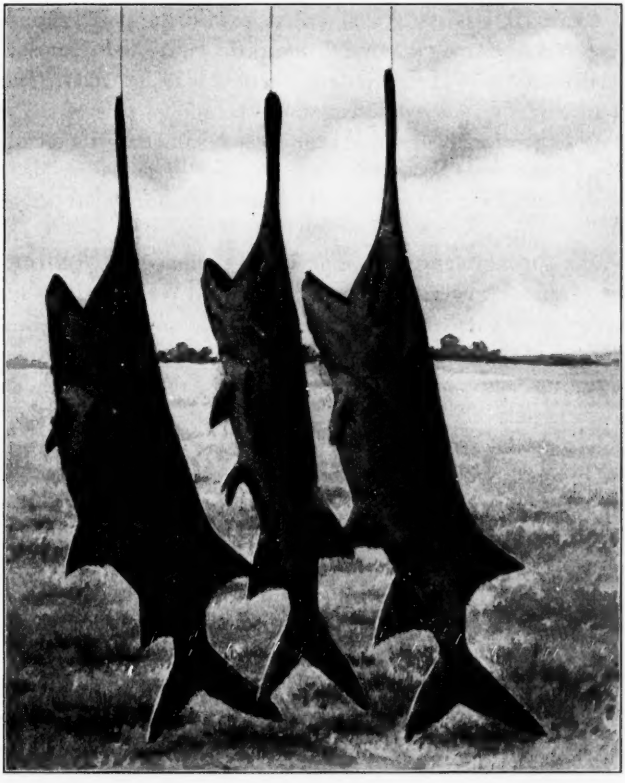


FIG. 1. — Three large specimens of Polyodon. The middle fish, from the river, is thin and slender, showing a torn fin and scars received while migrating. In contrast, the lake-fishes on either side are fat and well rounded, the one on the left showing an unusually distended abdomen although it is a male.

dition have so extensive a mass of adipose tissue about the testes that their abdomen is almost equally swollen. The fat about the testes of one male was found to weigh three and three-quarters pounds.

The larger females contain an enormous number of eggs. Sixteen pounds of roe was the heaviest single yield observed, but the maximum is no doubt greater; ten to twelve pounds was an average yield. The egg resembles that of Acipenser very closely in size and color. It is slightly oval in shape with the polar diameter longer and measuring about 2.7 mm.; the equatorial diameter is only about 2.2 mm. It is of a dark brown or blackish color. There is a considerable polar differentiation, the animal pole of the egg having a cap of lighter colored protoplasmic material with a rather distinct dark ring about its lower border. The denser deutoplasmic part of the egg is gradually located about its lower, vegetal pole.

Various measurements were made on a number of fish in the hope of discovering some sexual difference. While making such measurements a rather interesting ratio was found to exist between the length of the fish and that of the snout, as will be seen by referring to the accompanying table. In the table the individuals are arranged in the order of their lengths, the longest fish being at the top of the column. The entire length of the fish is expressed in inches in the first column and the length of the rostrum, from the anterior border of the eye to the tip of the snout, in the third column; by dividing the latter measurement by the former in any one case, the decimal given in the fifth column is obtained. The decimal, then, represents the fraction of the entire body length which is formed by the snout, and it is seen by comparing the data given for fifteen individuals selected at random, that the proportionate length of the snout decreases gradually and quite regularly as the fish increases in size. In other words a small fish, about two feet in length, has a snout one-third of the length of its body or eight inches long; and the large fishes, like the third and eighth individuals of the table, may have snouts less than one-fourth of their body lengths. Between these extremes one finds a regular gradation as is shown in the fifth column of the table.

TABLE I.

Length in inches	Sex	Length of rostrum	Weight	Proportion of rostrum length to body length	Remarks
69	♀	17.87	——	.258	Lake fish. 8 lbs. eggs.
67	♂	17.00	43 lbs.	.253	Lake-fish.
66	♀	15.75	41 "	.238	River-fish.
63	♂	16.50	62 "	.264	Lake-fish.
63	♀	15.75	90 "	.250	Lake-fish. 12 lbs. eggs.
62	♀	16.00	57 "	.258	Lake-fish.
60	♂	15.90	54 "	.266	Lake-fish.
59	♂	14.00	50 "	.237	Lake-fish.
53	♀	13.50	23 "	.254	River-fish.
51	♂	13.50	——	.265	Lake-fish.
49	♀	13.10	31 "	.267	Lake-fish.
44	♀	12.00	25 "	.272	Lake-fish.
36	♀	10.20	18 "	.283	Lake-fish.
30	♂	9.00	——	.300	Lake-fish.
24	♂	8.00	——	.333	Lake-fish.

By means of the above proportion one may calculate approximately the size of a fish from a small drawing. To test this I measured and calculated the proportion of length of rostrum to length of body in the Polyodon figured in Jordan and Evermann's Pl. XX, figs. 43 and 43a; the proportion found was .327 which according to the table would indicate that the specimen was about twenty-five or twenty-six inches long. Calculating from the inch line which accompanied the figure I found that the specimen was 27.2 inches in length, a very close agreement with my expectation.

From a few comparisons made between fishes living in the lakes and those in the river, it appears that the river fish have shorter and broader snouts in proportion to their entire body length than those living in Lake Washington.

HAUNTS AND HABITS OF POLYLDON

The lakes in which these fishes are found in great abundance are the old "cut off" lakes of the Mississippi River. These crescent or horse-shoe shaped bodies of water were formed from time to time as the course of the river changed. Some of them are at present almost completely separated from the river, being connected only by a long chain of bayous and lagoons, oftentimes

almost one hundred miles in length. Other such lakes still retain a direct connection with the river and are termed by the fishermen "river-lakes." In these there is a current which often becomes very strong during the spring freshets, when the water of the Mississippi River rises.

Lake Louis in Catahoula Parish, Louisiana, is a very old lake, being now only from one to three hundred yards in width and about six miles long. During the spring floods the Ouachita River sends a large volume of "backwater" into it, sometimes causing it to rise as much as twenty feet. In many places the lake is from forty to fifty feet deep. Polyodon exists in this lake in large numbers, but it is an undesirable place for seining and therefore offers poor facilities for the study of the fish. Lake Washington in Washington County, Mississippi, is by far the richest source of Polyodon that I have been able to locate. This lake is a beautiful body of water more than one mile across in several places, and about twelve miles long. It connects with the Mississippi through about seventy miles of smaller lakes and bayous. As many as one hundred and fifty barrels of Polyodon have been caught in this lake at one haul of the enormous seine described below.

Polyodon, like most large fish, frequents the deeper portions of these lakes and is rarely caught in the shallower parts. It is almost never found in lakes less than ten feet in depth. Usually it is caught in those parts of the lakes having soft muddy bottoms, the sections with hard sandy bottoms yielding no Polyodon when seined. This is due to the feeding habits of the fish. The main diet of Polyodon consists of small Crustacea, usually copepods. These are very probably obtained by stirring the muddy bottoms and gulping in the agitated material, which is then effectively strained by means of the long slender gill-rakers, so that only the small arthropods remain in the mouth to be swallowed. One may often scrape more than a double-hand-full of these Entomostraca from the mouth of a Polyodon freshly brought up by the seine. The copepods were often alive, with their egg strings still intact, and in good condition for preservation. Jordan and Evermann state that "They (Polyodon) feed chiefly on mud and minute organisms contained in it, stirring it up with the spatulate snout." One must surmise from the general structure of the mouth and

gill-rakers that they feed on minute organisms, but Jordan and Evermann are surely in error, so far as my observations on some four hundred stomachs go, in stating that they feed chiefly upon mud. No doubt some fine mud or silt is taken into the throat along with the food, but it appears to be well strained out, since scarcely any mud has been found in the many stomachs examined.

FIG. 2. — Ventral and dorsal views of a Polyodon measuring 4 feet and 7 inches. Its rostrum had been broken off during life and the wound had healed as seen in the photographs.

The contents of several stomachs were preserved in mass, and little if any silt has settled out from the animal material.

The function of the peculiar long rostrum or snout has not been definitely determined. There are some reasons for believing that the organ is used in procuring food but the following facts indicate that it is not essential for such a purpose. During the two springs

three specimens were found which had, through some mishap, been left with only stumps of their snouts. Fig. 2 shows a photograph of such a fish. In each case the fish was large, two being nearly four feet in length and the other measuring four feet and seven inches. In each the injured part of the snout was well healed, but no indication of regeneration of the organ was shown. It is evident from these individuals that this fish without the aid of its snout is capable of procuring food enough to maintain a large body. Moreover if the appendage was lost while they were yet small, they had succeeded in increasing in size without their "spatula with which to agitate the mud."

Fishermen state that large holes are often rooted out in the lake bottoms by the digging of Polyodon with its "paddle." In the bottoms of drained lakes, places resembling "hog-wallows" are found, which Polyodon is thought to have dug while feeding. Such statements are difficult to substantiate and yet there is probability that they are true, for there are immense numbers of Polyodon herded in one of these almost land-locked lakes, and they feed over the muddy bottoms.

Observations on the general behavior of this fish lead me to a rather skeptical position regarding the foraging value of the rostrum. I am inclined to regard it more as a tactile organ since the sense of sight is of so little use to the fish while swimming forward. Again its use for digging seems to be restricted as indicated by the actions of this fish when its rostrum strikes against any foreign object. When, for example, Polyodon is surrounded by a seine and happens to swim against the net at any place, it very often stops when its rostrum strikes the net; sometimes it continues to push forward by one or two indifferent efforts, and then gives up entirely, turning over on its back and floating along the cork-line of the seine. In a large haul fifteen or twenty fishes may be counted floating along the cork-line with their white ventral surfaces turned upward. Sometimes they may float thus on the outside of the seine and stupidly allow themselves to be picked up by the fisherman who guards the line in a row-boat, in order to catch the fish that float over while the seine is being hauled in. The larger and more active fishes often strike the seine several times before surrendering, but even they show but little ability

to back-off when their snouts strike against the net. From such actions one is led to think that if these fish should swim with much force into mud of a very viscid consistency, they would oftentimes be trapped, for from the above observations they appear too stupid to pull back and loose themselves. Since the fish lacks the power to turn its head from side to side, it cannot stir the mud with its spatulate snout, as Jordan and Evermann claim, but must agitate the silt by a general movement of its entire body. In this process the spatula no doubt plays an important rôle since it is a considerable portion of the anterior end of the body.

The food of Polyodon is extremely abundant in the lakes, and they grow to be very large and heavily proportioned in such places. One may distinguish almost at a glance between a fish that has lived in the lakes and one from the river; the latter is poor and slender as compared with the former. The lake-fish contains a much heavier roe, averaging ten or twelve pounds, whereas river-fish often have only three or four pounds.

The stomach of Polyodon, in addition to its crustacean diet, contains great numbers of a cestode parasite, *Dibothrium hastatum* (Linton). Hundreds of these little yellow-headed tape-worms measuring three or four inches in length are often present in a single stomach.

Polyodon like Lepidosteus is frequently seen to leap from the water during the spring; the leaping at this season is not so common, however, as it is later in the year. During the summer months one may often see several of these large fishes in the air at the same time. They make a vigorous jump, usually clearing the water entirely, and at times turning over backwards in the air so as to enter the water either head foremost or by striking on their backs. Apparently one fish may sometimes be seen to jump repeatedly at short intervals near the same spot. The object of such leaping is difficult to detect unless it be on account of the stagnant and poorly aerated condition of the water during the dry summer, when it becomes unusually low in these lakes.

Polyodon shows a considerable migratory tendency. During the spring, when the water of the Mississippi River rises for several feet and backs into the bayous, thus establishing connections with the large lakes, Polyodon begins immediately to come into the

lakes from the river and continues to come in large numbers so long as a sufficient connection is maintained. To do this it must often make long journeys through rather shallow water in which many obstructions, such as bushes and trees, are frequently met. Thus it finally reaches the lakes in a rather emaciated condition and with its body scarred and scratched. By referring again to Fig. 1 the river-fish in the middle will be seen to show such marks even in the photograph. It is equally true that the fish in the river-lakes (those lakes more directly connected with the river) migrate out into the river when the water begins to back in during the spring, so that fishermen often abandon their fishing in these places at such a season, since most of the desirable Polyodon have made their escape.

SPAWNING HABITS

I was unable, on either of my trips, to find fishes in a "running" condition or to locate a party in the act of spawning. By constantly watching the fish and taking numbers in the seine each day I concluded that the breeding season in this region occurs about the middle and latter half of April. The fish seem to breed only in running water, most probably in the bayous and small wooded lakes connected with the Mississippi River. My reasons for such conclusions may be gathered from the following observations.

During the first half of the month of April five females were taken which had their ovaries well filled with almost mature eggs. On April 4, 1905, three females of not unusually large size were examined and contained respectively sixteen, thirteen, and twelve pounds of roe. Such fish were taken in the lakes until shortly after the first of May when the following condition was observed. On May 5th a female five feet and nine inches in length, which weighed eighty pounds, was found to contain only eight pounds of eggs. Many of these eggs had taken on a whitish appearance and were very soft, so that on attempting to strip them from the ovarian membranes they broke and formed a milky pulp. After this time, fish from five different lakes were examined and all were found to be in a similar condition. Not one male Polyodon in any of the

lakes was found to be "running" although I examined from ten to twenty on almost every day from April 1st until May 13th, 1905.

A number of males and females were from time to time placed in a large wire-netting pen, with the object of keeping them until they reached the spawning condition. Some of these lived in the pen for four or five days but rarely longer, although the pen was twenty feet square and rested on the bottom of the lake. The larger ones are especially difficult to keep in confinement. The eggs of the confined females soon began to degenerate and soften, like those of the lake-females mentioned above.

After April 10th, 1905, the Mississippi River began to rise and river-fish were taken in Lake Washington after April 14th; several of these females on dissection were found to have spawned. The ovaries contained only a few defective eggs still attached to the membranes of their ventral border. The anal region was inflamed and other external appearances, such as their lighter pinkish color, made it practically certain that these fishes had deposited their eggs in a normal manner. I then concluded that the large fat lake-fish was unable to spawn in the still waters, and that its eggs were absorbed within its body after they began to degenerate. The males also seem to fail to arrive at the "running" stage, as none were observed in such a condition during either season.

An attempt was made to locate a spawning party in the running bayous leading into the river. On May 16th, 1905, great numbers of Polyodon were seen swimming and darting in all directions near the surface of the water in a small bayou in Washington County, Mississippi. This was the first time these fish had been observed swimming near the surface, and their spirited actions made one think them a spawning party. A zig-zag gill net one mile in length was dropped in the midst of these fish and within less than one hour one hundred and thirty-three large Polyodon had been lifted into the flat boat. On examination they proved to be river fish that were migrating up the bayou into the lake. All of the mature ones had apparently spawned some time before. They doubtless spawned near the mouth of this bayou which was about sixty miles distant, and with the rising water they began to swim up toward the lake. The fact that the lakes are so readily depleted of their stock of Polyodon by seining and are not again

able to repopulate themselves also indicates that the fish are non-productive in such places. Lakes that have been exhausted of Polyodon will remain so for years, unless the river rises sufficiently to permit the immigration of more fish to restock them.

Only one man was found who had probably observed Polyodon in the act of spawning. He related the way in which he had rowed a boat into a party of "Spoon-bills" during April several years before, and had succeeded in killing nine of them with an oar without being able to frighten them from the place. He said that this occurred in the edge of a wooded overflow border of a bayou, several miles from where it ran into the river.

It is curious that Polyodon does not spawn in the large clear-water lakes since the related *Lepidosteus osseus* and *L. tristoechus*, both being ganoids abundant in this region, spawn in great numbers in these lakes. A spawning place of Lepidosteus was visited on April 1st, 1905, though at this time only a few unhatched eggs remained and all of the larvae had swam away. The fisherman informed me that this party had spawned about March 15th. "Runners" of both species of Lepidosteus were taken in the seine until April 20th, so that their spawning season seems to continue here for several weeks.

METHODS OF CATCHING POLYODON

The commercial value of Polyodon is scarcely indicated in Jordan and Evermann's statement,— "the flesh [is] coarse, resembling that of the larger cat-fishes, but inferior in quality." For the past ten or twelve years the roe of Polyodon has been used as a commercial substitute for sturgeon caviar. Generally the Polyodon eggs are mixed with those of the sturgeon, so that the less attractive flavor of the former is not so evident. The flesh of Polyodon is shipped to the northern cities where it is dried or smoked and sold in the markets as dried sturgeon. The rapid decrease in the supply of sturgeon for the last ten or fifteen years has caused a strong demand on the part of the dealers for a substitute, and until now Polyodon is the only one successfully tried. The demand for Polyodon has caused an extensive fishing industry

to spring up in the lower Mississippi River region, until it has become the most valuable fish of these waters. This fishing industry is conducted in various degrees of perfection, and some of the more intelligent fishermen have very extensive apparatus for procuring Polyodon. On Lake Washington, Mr. McGehee, through whose kindness I was enabled to make most of the obser-

FIG. 3. — The upper photograph shows a crew of Polyodon fishermen putting out a seine almost two miles in length; in the lower photograph they are winding it in on the reel.

vations above recorded, directs a most efficient fishery. He runs two seines, one nearly two miles long and thirty feet deep, the other about one mile long and fifteen feet deep, for use in shallower water. These huge seines are wound upon a large reel which is constructed on a heavy barge. In laying out the seine for the catch, the barge is towed by a gas launch around a circular area

more than a mile in circumference. The barge is then securely anchored and a crew of about a dozen men proceed to wind in the seine by means of the reel, as shown in the photograph, Fig. 3. It requires usually about four hours to haul the seine. Great numbers of Polyodon are caught in such a manner, more than one hundred and fifty barrels bring the record for a single haul in Lake Washington.

The roe or caviar is much more valuable than the flesh of the fish, and during my stay on these lakes there was an average of one caviar fish to every twenty-four other individuals. The roe is taken from the fish enclosed in the ovarian membranes and then strained through a screen which serves to separate the eggs. A liberal amount of a calcium-free sodium-chlorid salt is then added, and the eggs are packed in kegs for shipment to the markets. One fisherman may ship as many as seventy-five of these hundred and fifty pound kegs in a single season, from November to April. At such a rate one is not surprised to learn that Polyodon has decreased greatly in numbers since the beginning of this new industry. At present many lakes that were formerly crowded with these fish are completely depopulated. The methods of seining are very exhaustive and as above mentioned the lakes are only restocked when the river rises sufficiently, which may not occur for a period of several years. River seining is almost impossible owing to the strong currents. This industry though in its infancy is decidedly on the wane; many of the most prosperous fishermen have now abandoned it entirely on account of the great decrease in the number of fish. Such an extensive apparatus is essential for taking the large Polyodon that the fishing is unprofitable unless they are caught in great numbers.

As I have stated, my attempt to secure material for a study of the embryonic history of Polyodon was unsuccessful. The observations presented in this paper, however, indicate when and how such material may be obtained. I expect to visit these regions again and to arrange with some well equipped fisherman to seine one of the running water lakes so that fish may easily be taken during the entire season. Thus it is hoped that the desired material may be procured.

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FOWLER'S "HETEROGNATHOUS FISHES" WITH A NOTE ON THE STETHAPRIONINAE[1]

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At divers times and places I have pointed out that the South American heterognaths, or characins, offer us an unparalleled opportunity for a study of divergent evolution. They probably entered South America in the early Tertiary, when the continent was small and its river systems comparatively insignificant. They have literally grown up with the country, keeping pace with the development of its unrivaled freshwater system. To-day there are over one hundred genera and more then five hundred species known, and only a few spots have been examined. For the most part the genera represent steps along different directions of adaptation.

Every one identifying miscellaneous collections of fishes or other animals, without critical revision of the respective groups, will make numerous mistakes in identification; he will emphasize in his descriptions characters of no importance, and will omit or slur others that are significant. The percentage of mistakes made in identification and the number of unsatisfactory descriptions vary with different men. A large percent is found in the ichthyological writings of the late Professor Cope. His South American freshwater fishes have especially been a source of tribulation for recent writers. It is a thankless task for any naturalist to go over such work and yet this is what Dr. Henry W. Fowler has recently done for the characins.[2] Dr. Fowler has redescribed many of Cope's species and has supplied illustrations of those not figured or only unsatisfactorily figured before.

It is inevitable that new questions concerning the specimens should arise as the result of Dr. Fowler's work, and that he should

[1] Contribution from the Zoological Laboratory of Indiana University No. 90.

[2] Further Knowledge of some Heterognathous Fishes. *Proc. Acad. Nat. Sci. Phila.*, 1906, pp. 273–351 and 431–483, 60 figures.

make new mistakes. With the limited material at his command it is to be regretted that Dr. Fowler has not confined himself largely to figuring and describing, instead of bestowing new generic and subgeneric names with princely liberality and abandon. While he has helped by his figures and descriptions, he has in large measure increased, rather than lightened, the burdens of his successors.

The new genera and subgenera proposed by Dr. Fowler (24 in number) are consecutively numbered in the following notes:

1. — Ophiocephalops. This is an exact synonym of Hoplerythrinus of Gill.

2. — Copeina, a new name for the genus Holotaxis of Eigenmann, not Cope. This is probably a valid name.

3, 4, 5. — Curimata is used for Curimatus, although the latter is the earlier form. The genus is divided into the subgenera, (3) Cyphocharax, (4) Steindachnerina, (5) Peltapleura, and Curimata. The known species of the genus are not distributed to their respective subgenera and there is no evidence produced in this paper demonstrating that these subgenera are valid or that Dr. Fowler is able to delegate the species to their proper subgenera. Cyphocharax and Curimatus are probably valid. It is to be hoped that Dr. Fowler will distribute the species for us.

6. — Eigenmannina, a new generic name for *Anodus melanopogon* is apparently valid.

7. — Chilomyzon is a new subgenus of Prochilodus, distinguished by having 33–38 scales in the lateral line, whereas Prochilodus is said to have 40–60. This division is unfortunate since *P. humeralis* has 33 scales, *vimboides* 35–37, *oligolepis* 36–38; *longirostris* 38–39, *magdalenae* 40–41, *cephalotes* 41, *asper* and *hartii* 41–42, *brevis* 41–43, *rubrotaeniatus* 44, etc., to the end of the series. The new species, *Prochilodus theraponura* and *amazonensis* are very probably two stages ($2\frac{1}{4}$ and $4\frac{3}{8}$ inches long) of the common *P. insignis*.

8. — Hemiodopsis, a subgenus of Hemiodus, distinguished by having 100 scales. Since the other species of Hemiodus have 58–85 scales this division may be convenient.

9. — Pithecocharax is substituted for Anostomus because he thinks the latter is preoccupied by Anastomus *Bonnaterre* 1790.

But Anostomus was proposed by Gronovius and accepted by Scopoli in his *Introductio ad Historiam Naturalem*, 1777, p. 451. There is no reason for doing away with the name Anostomus even if it were identical with Anastomus, which it is not.

10. — Poecilosomatops is proposed for the species of Characidium having 4 scales between the anal and the lateral line; the rest have 2 or 3. The advisibility of this division may well be questioned, but even if valid, the older name, Nanognathus Boulenger, must be used instead of Poecilosomatops.

11. — Garmanina is a valid subgenus of Rhytiodus, there being a difference of 30 scales in the lateral line.

12. — Abramites (type *hypselonotus*), a new genus, is said to be distinguished from Leporinus by its longer anal basis, but where are we to draw the line? There are groups of species of Leporinus with 9, 10, 10 or 11, 11, 12, 12 or 13, 13 to 15 (*hypselonotus*), 14, and 15 or 16 rays! The name is not admissible.

Astyanax pectinatus (Cope) redescribed and figured, is the type of a genus distinct from Astyanax, differing from all other Tetragonopterinae in that the origin of the anal is under or in advance of that of the dorsal. It may be named Phenacogaster.[1] *Astyanax moorii* (Boulenger) is the type of a distinct genus which may be named Astyanacinus.[2] *Astyanax atahualpinus* does not seem to be distinct from *Moenkhausia agassizii*, since the differences fall within the limits of the observed variation of the latter. His *Astyanax oligolepis* is very probably *Astyanax steindachneri* Eigenmann; it certainly is not the *oligolepis* of Günther. *Tetragonopterus ovalis* is probably a Moenkhausia.

13. — Coscinoxyron is probably a valid genus, differing from Chalcinus in the increased number of gill-rakers.

[1] It is very probable that *Tetragonopterus bairdii* and *T. tabatingae* belong to this genus.

[2] The following description is based on the type in the British Museum.

Jaws equal, the lower not included; premaxillary with two series of teeth; mandible without conical teeth in front; gill rakers setiform; snout and maxillary forming more than half the length of the head; maxillary not slipping under preorbital for its entire length, the preorbital notched; maxillary with about 6 teeth; lateral line complete; maxillary-premaxillary border without a distinct angle. Differing from Hollandichthys and Pseudochalceus in its complete lateral line and incompletely toothed maxillary, from Creatochanes in its complete lateral line, notched preorbital and unangulated premaxillary-maxillary border.

14. — Thoracocharax, proposed as a subgenus of Gasteropelecus because the "Anterior profile of back [is] convex," is a distinct genus characterized by its dentition and not by the degree of the convexity of the back.

15. — Cyrtocharax is synonymous with Cynopotamus, a subgenus of Charax. The type of Cynopotamus lacks a second row of teeth in the lower jaw.

16. — Eucynopotamus may be used for the genus hitherto known by the name Cynopotamus, since the type of this genus does not possess the generic characters distinguishing the other species hitherto relegated to this genus from Charax. The division of this genus into a subgenus with less than 75 scales and another with more is not fortunate, since the scales are 76–77, 79–97, 110–120 and 115 respectively in *gulo*, *knerii*, *magdalenae* and *humeralis*.

17. — Cynocharax, a new *subgenus* of Roeboides, I am unable to pass judgment upon in the absence of material and through the neglect of Dr. Fowler to state what species it includes.

18. — The subgenus Sphyraenocharax is said to be distinguished by having the depth $3\frac{1}{2}$ to 4 in the length. It apparently consists of *brachycephalus* and *abbreviatus*, with the latter the type. The teeth are too imperfectly redescribed to place them. Cope's figure of *brachycephalus* shows it to be allied to the type of Acestrorhamphus. The character of the teeth of *abbreviatus* is still in doubt. Cope says: "There are two distinct large canines on the anterior part of the maxillary bone and four smaller ones; maxillary teeth are minute." Presumably the first "maxillary" is a misprint for *premaxillary*. Fowler says: "about 6 well developed [canines] in the upper" jaw. This species is also allied to the type of Acestrorhamphus. Now the type of Acestrorhamphus has a depth of $3\frac{1}{2}$, other species of the genus have a depth of 4 and I am unable to discover the semblance of an excuse for the name Sphyraenocharax.

19. — Belonocharax is a new genus based on specimens from the Truando, Rio Atrato basin. These same specimens were referred to by Gill (in 1861 I think), as Ctenolucius. Admitting that Gill's name, being undefined, has no standing, there is no excuse for passing over the *Luciocharax* (*insculptus*) of Stein-

dachner, defined and figured in his *Fischfauna des Magdalenen-Stromes*, p. 51, pl. XIII, figs. 2–2b, which is unquestionably the genus to which *Belonocharax beani* belongs, *beani* being probably identical with the type *insculptus*.

20, 21, 22. — I do not have the material to pass finally on the status on the subgenus (20) Waiteina and the genus (21) Reganina; both are apparently Colosoma, as (22) Starksina is probably a Mylosoma.

24. — The genus Sealeina is probably a valid subgenus of Metynnis.

The paper closes with descriptions and figures of Cope's two species of Stethaprion. The figures lack details of the predorsal spines which are essential. No attempt is made to compare critically these two species and pass judgment as to whether the one is simply a younger specimen ($2\frac{13}{16}$ in.) than the other ($3\frac{9}{16}$ in.) although no one else is in as good a position to do so.

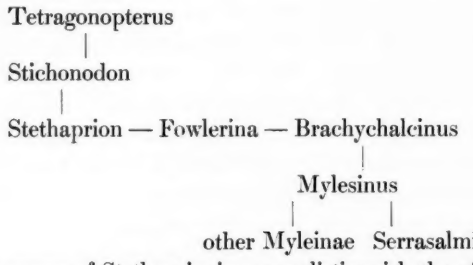
The descriptions of Cope, pieced out with those here presented and the numerous figures, will enable us without prejudice to work out finally in most cases what species are really under consideration.

We must feel grateful to Dr. Fowler for his labor. But it is to be hoped that in the future he will be more conservative in adding names to the science of ichthyology. The valid names do not compensate for the work imposed on some one else to separate them from the synonyms.

An examination of Boulenger's types of Brachychalcinus shows them to belong to two distinct genera. Referring Boulenger's name to the species figured by him, the other species is congeneric with Günther's *Tetragonopterus compressus* and most nearly allied to Cope's Stethaprion. In recognition of Dr. Fowler's generous effort I would propose, using a form adopted by Dr. Fowler, the name Fowlerina to distinguish the genus represented by the *Tetragonopterus compressus* Günther.

The members of the Stethaprioninae mark the direct road from the genus Tetragonopterus (Tetragonopterinae) in its narrowest sense to the Myleinae and Serrasalminae. In the deep *Tetragonopterus argenteus* the post-ventral region is trenchant, the pre-ventral region flat. In Stichonodon both pre-ventral

and post-ventral regions are trenchant. In Stethaprion, Brachychalcinus and Fowlerina the post-ventral region is incipiently serrate and there is a pre-dorsal spine. In Mylesinus of the Myleinae the abdomen is serrate behind the ventrals and in the rest of the Myleinae and the Serrasalminae the ventral edge is serrate both in front and behind the ventrals. The descent is indicated as follows



The genera of Stethaprioninae are distinguished as follows.

a. No predorsal spine; caudal scaled; origin of anal posterior to dorsal. . . . . Stichonodon.

aa. A predorsal spine.

b. Predorsal spine long, slender, spear-shaped, fitting into a groove in the back; origin of anal under dorsal; scales rather small, over 60 in the lateral line. Stethaprion.

bb. Predorsal spine scale-like, spoon or saddle-shaped, concave below, fitting into a notch in the back. Caudal scaled; scales less than 40. . . . . Fowlerina.

bbb. Predorsal spine trigger or hammer-shaped, its free portion forming a longer anterior and shorter posterior branch, both of which are sharply pointed; caudal scaled; scales large, about 40. . . . Brachychalcinus.

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PINK INSECT MUTANTS

WILLIAM MORTON WHEELER

THE present wide-spread interest in mutation lends fresh significance to the cases of dichromatism and trichromatism among insects, and suggests experiments in breeding these animals under laboratory control. The sporadic occurrence of pink individuals among our commonly leaf-green katydids (Locustidae) belonging to the sub-families Phaneropterinae and Pseudophyllinae, and especially in our two species of Amblycorypha, has been known for some years. Scudder called attention to some of these individuals in three brief papers (1878, 1897, 1901), and published a fine colored figure of a pair of them on a spray of golden rod.[1] From time to time other authors have recorded similar observations. Certain Homoptera, as I shall show presently, also exhibit color aberrations of the same kind. The following are the cases of pink Locustidae of which I find records in the literature:

Cyrtophyllus perspicillatus L.

No. 1. A single specimen taken at Point Pleasant, N. J. Sex and date of capture not mentioned (Lewis 1883).

C. roseus Stål.

No. 2. The type of the species from Chiriqui, Costa Rica, cited by Scudder (1901).

Amblycorypha rotundifolia Scudder.

No. 3. Female, taken August 29, on Sharp Mountain, Schuylkill County, Pa. Recorded by Scudder (1878) who received it from Leidy.

[1] Entomol. News, XII, 1901, Pl. VI. This plate is reproduced by Blatchley (1902).

No. 4. A single specimen from Pennsylvania. Date and sex not recorded (von Wattenwyl, 1878).

A. oblongifolia DeGeer

No. 5. Female, taken by Professor G. Thurber, presumably in New York State (Riley 1874).

No. 6. Specimen without record of date, sex or locality (Johnson 1889).

No. 7. Female, taken August 9, at Woods Hole, Mass., by Mrs. Sidney I. Smith (Scudder 1897).

Nos. 8 and 9. A male and a female specimen taken August 29, at Woods Hole, Mass., by Mr. Richard Rathbun and Professor A. E. Verrill (Scudder 1897, 1901).

Nos. 10 and 11. Two individuals belonging to a "number of pink specimens" taken near Bass Lake, Starke County, Indiana, by Mr. Frank Hay. Sex and date not recorded (Blatchley 1902).

Nos. 11 to 14. Three female specimens taken many years ago at West Farms, now a part of New York City, by Mr. J. Angus (American Museum of Natural History).

Nos. 15 to 17. Three specimens taken on Staten Island, N. Y., by Mr. William T. Davis. Two of these, both females, captured during August and September, are in Mr. Davis's collection.

No. 18. Female taken August 22, 1906, at Upper Montclair, N. J., by Mr. C. B. Wolff (American Museum of Natural History).

Nos. 19 to 23. Five females taken during August 1906, at Woods Hole, Mass., by members of the Marine Biological Laboratory (Professor T. H. Morgan *in litt.*).

No. 24. Male taken August 12, 1906, on Grosse Isle near Detroit, Mich., by Mr. A. S. Austin (Shull 1907).

No. 25. Female in the Museum of the University of Michigan. Date and locality not recorded (Shull 1907).

No. 26. Female taken August 31, 1907, at Winslow, N. J., by Mr. H. H. Halsted (American Museum of Natural History).

Conocephalus rosaceus Walker

No. 27. Female, the type of the species, from North China, in the British Museum (Walker 1869).

It will be noticed that the geographical range of the pink *Amblycorypha oblongifolia* is nearly or quite co-extensive with that of the green form, and that the great majority of pink individuals enumerated in the list are females. This may be due either to the females of the species in general being more numerous than the males, or to the males being much shorter-lived than the females. Careful comparison of the pink with the common green forms fails to reveal any differences, except those of pigmentation. The color of all the aberrant specimens of *Amblycorypha oblongifolia* which I have seen, is very constant, although some of those seen by others have been described as vermilion or crimson. The exquisite tint of the living insect changes rapidly after death and becomes a dull pinkish brown in the cabinet. In green individuals, however, the post-mortem color change is less marked, so that we are justified in saying that the pink pigment is less stable than the green.

The pink katydids which have been observed in confinement show nothing unusual in their behavior, nor anything to suggest a diseased or abnormal condition. Those observed both by Scudder (1901) and myself ate green leaves and drank water with avidity, and eventually laid eggs of the normal form and size. Nos. 17 and 25 each lived in a jar in my laboratory for nearly six weeks. I endeavored to mate No. 17 with a male of the green form, but failed, perhaps because the experiment was tried too late in the season, or because the male may have been moribund or exhausted before it was placed in the jar with the female. The eggs laid by this insect a few days before her death were not fertilized. No. 25 had laid a number of eggs before she was sent to me by Mr. Halsted. According to Scudder (1878), specimen No. 3 oviposited while she was still in Leidy's possession.

It seems not to be generally known that, in addition to the green and pink forms, both *Amblycorypha rotundifolia* and *A. oblongifolia* have also a brown phase. Mr. William T. Davis has generously loaned me two males of the latter species in this phase, one taken by him July 24, at Hewitt, N. J., and the other during September, on Staten Island. In these I can detect no peculiarities except those of color, the usual green being merely replaced by a yellowish brown or tan tint, which was probably more vivid in the living specimens. Several authors have recorded the occurrence

of both green and brown individuals in some of our species of cone-headed grasshoppers (*Conocephalus nebrascensis* Bruner, *C. robustus* Scudder), which are not known to have a pink phase, although Walker (1869) has based his *C. rosaceus* on a pink individual of this genus from Northern China. In *C. robustus* the brown and green colors are occasionally found in the same individual, a condition that, to my knowledge, has never been met with in the species of Amblycorypha.[1]

I find that certain green species of Homoptera belonging to the families Jassidae and Fulgoridae occasionally present striking color aberrations comparable to those of the Locustidae. Ball (1900) described as var. *paeta* a red individual of the green Jassid *Macropsis laeta* Uhler and noticed its resemblance to the pink phase of the katydids. Mr. William T. Davis has loaned me series of specimens of the jassid *Gypona geminata* Osborn, and of the fulgorid *Amphiscepa bivittata* Say which are of peculiar interest in this connection. The Gypona series comprises three specimens of the common green phase taken September 6, at Lakehurst, N. J., three brown individuals taken at the same time and place, and two pink specimens from Staten Island (September 11). There is also in the collection of the American Museum of Natural History a pink individual of the same species taken by Mr. J. Angus, at West Farms, N. Y. On closer examination the ventral surface and ground color of the pink specimens is seen to be greenish yellow (probably green in life), with irregular crimson markings on the head and thorax, and elytral veins of the same color. In the other specimens the brown and green colors are more diffused over the whole surface, especially on the dorsum, and there are no distinct markings on the head, thorax and elytra. The common form of the well-known *Amphiscepa bivittata* is pea-green, with the head, sides of thorax and scutellum, the posterior margins of the elytra and wings and the anterior legs, purplish brown. A single specimen in Mr. Davis's series has the green portions of the dorsal surface and elytra replaced by pink, with the veins of the latter somewhat

[1] Mr. Davis has shown me brown specimens of the following seven species which also present a green phase: *Conocephalus fuscostriatus* Redt., *ensiger* Harris, *lyristes* Rehn., *triops* L., *robustus* Scud., *candellianus* Davis, *exilis canorus* Davis.

purplish. This specimen, which is somewhat smaller than the green ones, was taken August 9 on Staten Island, by Mr. Joutel.

What is the significance of these peculiar pink and brown forms which appear so sporadically among our green Orthoptera and Homoptera? As Scudder says, everyone who sees one of these rare insects for the first time, "thinks at once of autumn leaves and their changes from green to red, and notices that these grasshopper cases all occur in the autumn, so far as known." But further reflection soon leads one to doubt a conclusion based on such a superficial analogy, for it is evident, in the first place, that the colors of these insects must differ greatly from chlorophyll or other plant pigments, and, in the second place, the occurrence of the pink individuals during late summer may have no significance, since it is only during this season that even those of the common green phase reach full maturity. In this connection, Scudder (1901) also calls attention to the occurrence of *Cyrtophyllus roseus* in tropical Costa Rica.

There is, however, another fact hitherto unrecorded, which seems to me effectually to dispel the notion that the pink phase can be the result of temperature acting on the green pigment. Some years ago, while I was sweeping the low vegetation in the prairies of Wisconsin and Illinois for small Diptera, I took in my net, on one or two occasions during July, a few pink larval and nymphal katydids. Unfortunately I did not preserve the specimens as I was at that time collecting Diptera only, but I retain in my memory a vivid picture of the specimens. They varied from one to two centimeters in length, and were either wingless or had small rudiments of wings. They were pink throughout, like the adults which I have seen since, and occurred sporadically in the same sweepings with many specimens of the common green form. These larval and nymphal individuals show that the pink katydid is pink throughout life and this is in all probability true *mutatis mutandis* of brown individuals and of the pink and brown Homoptera also. In other words, the pinkness or brownness are, like the greenness, congenital or germinal characters and not the result of environmental conditions. This being the case, we must incline to the hypothesis advocated by Scudder and Shull, that the pink, and probably the brown individuals also, represent sports, or

mutants, as we should now call them. They have, in fact, every appearance of belonging to a category of color forms similar to that of the albino mammals and birds and certain kinds of white-flowering plants. If there were need of coining new words, we might call the pink individuals cases of *rhodism* and the brown ones cases of *phaeism*.

Conclusive proof of the correctness of this view can be obtained only by experimental breeding. On the sport or mutation hypothesis we should expect pink individuals mated *inter se* to produce only pink individuals, and the same should result *mutatis mutandis* in the case of the brown forms. Pink or brown individuals crossed with the common green form may be expected to give offspring in the Mendelian proportion, with the pink and brown characters acting as recessives. Perhaps some student at the Marine Biological Laboratory at Woods Hole, where pink individuals of *Amblycorypha oblongifolia* seem to be less rare than in other localities, may find it worth while to perform these and other experiments for the purpose of determining the inheritance value of the characters above discussed.

Postscript

Since the foregoing paragraphs were sent to the "Naturalist" two additional captures of pink *Amblycorypha oblongifolia* have been recorded:

No. 28. A female taken August 15, 1907, by Dr. J. N. Rose, in the New York Botanical Garden and presented to the National Museum, is cited by Knab (1907), who also mentions two brown specimens of this same species, one from Springfield, Mass., and another from Dorsey, Md. (August 20, Miss R. Jones). Knab calls attention to the pink and green caterpillars of the same species as analogous to the pink and green katydids, and concludes that the difference in pigmentation in the latter is in all probability due to the red or green coloring matter of the leaves on which the insects feed. I am unable to accept this view for the following reasons: first, red and green caterpillars are sometimes found on the same green plant and living under precisely the same conditions; second, my pink katydids in confinement ate green leaves

for several weeks without showing the slightest change in coloration, and third, red vegetation is not abundant early in August, and katydids, unlike caterpillars, roam about, feeding on a variety of plants and even on animal food.

No. 29. A pink male *Amblycorypha oblongifolia* was captured by Grossbeck (1907) August 1, at Lahaway, Ocean County, N. J. He also mentions several pink specimens taken some years ago by Professor J. B. Smith in the pine barrens of New Jersey, and a pink *Amphiscepa bivittata* taken August 23, by himself at Lakehurst, N. J. He says that in his experience *Gypona octolineata* (perhaps identical with the species above cited as *G. geminata*) "is almost as often pink as green." The title of Grossbeck's paper shows that he regards the pink phases of these various insects as sports, or mutants, and not as the result of the environmental conditions (temperature, food, etc.).

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NOTES AND LITERATURE

GENERAL BIOLOGY

The Theory of Mimicry.— In an address before the British Association, Dr. F. A. Dixey has reviewed the history of the mimicry hypothesis as an explanation of the resemblances in color pattern between butterflies of diverse genera (*Nature*, 1907, vol. 76, p. 673–678). After visiting the Amazon nearly fifty years ago, Bates suggested that of two species of similar pattern, one was distasteful to birds, and the other had acquired a protective resemblance to it through natural selection. Dr. Dixey states that this was "the first really scientific explanation of the matter" and that it "was at once, and cordially, accepted by Darwin." He continues,—

"Bates himself was not thoroughly happy about all the facts recorded. He directs attention to the circumstance that not only do the mimics resemble their models but that the models themselves often show an extraordinary resemblance to each other. He speaks of 'a minute and palpably intentional likeness which is perfectly staggering.'" It was thought that some local or climatic cause, acting equally upon the forms of different groups, might bring about the strange resemblance between them, and "in this supposition Bates was for a time followed by Wallace."

"It is not to be denied that there is a certain plausibility in this view concerning the direct action of external conditions. It is, for example, a striking fact that the members of a mimetic group of very diverse affinities will, as Bates says, every few hundred miles change their hue and pattern together 'as if by the touch of an enchanter's wand.'"

According to Dr. Dixey the key to the puzzle why distasteful forms resemble each other was found by Fritz Müller in 1879. Dr. Dixey states that his suggestion rested on the assumption, since shown mainly by Lloyd Morgan to be correct, that birds have no instinctive knowledge of what forms should be avoided. Hence a certain number of distasteful forms must be sacrificed until their enemies have learned to leave them alone. Now if two distasteful species resemble each other so closely that birds or other enemies do not distinguish between them, the disagreeable experience gained by tasting an individual of

one species will be applied to the benefit of the other, and so each of the two species will need to contribute only a portion of the tax instead of the whole. The greater the number of forms that can be got to share the tax, the better for all, and hence the formation of large 'inedible associations' or Müllerian groups.

In Batesian mimicry the advantage is all on the side of the mimic. In a Müllerian association the benefit is mutual, and Dr. Dixey cites examples showing that two insects may *each* become modified to resemble the other. He concludes that "the fertile suggestion of Fritz Müller went far to supply what was still wanting in Bates's interpretation. Expanded by Meldola and by Poulton, accepted by travelled naturalists like Wallace and Trimen, the Müllerian generalization has proved a powerful means of interpreting many complicated relationships."

Thus the theory of mimicry has been extended to explain not only resemblances between an edible and an inedible form but also between two inedible species. The question arises whether the resemblances have anything to do with edibility. Werner believes that they have not (*Amer. Nat.*, 1907, vol. 41, p. 333). Weismann has found it necessary to gather evidence that any birds eat any species of butterflies to an important extent.[1] He states that in Germany Caspari "let about a hundred butterflies (*Vanessa antiopa*) fly from his window, but not ten of them reached the neighboring wood, all the rest being eaten by swallows which congregated in numbers in front of his window." "Kathariner observed in the highlands of Asia Minor, a flock of bee-eaters which caught in flight and swallowed a great many individuals of a very beautiful diurnal butterfly (*Thais cerisyi*)." Several other such reports are recorded from various parts of the world, but they do not establish the fact that birds devour butterflies to the extent and with the discrimination which the theory of mimicry demands. The writer's observations in New England lead to the conclusion reached by Judd, that here the native birds seldom molest butterflies. He says,[2]—In the eastern United States....there are not yet any records of birds habitually preying upon butterflies. In fact the same question has been agitated in the discussion following the reading of Mr. Dixey's most interesting paper at the London Entomological Society; and it was found that comparatively few

[1]Weismann, A. The Evolution Theory. Translated by J. A. and M. R. Thompson. Vol. 1. London, Edward Arnold, 1904.

[2]Judd, S. D. The efficiency of some protective adaptations in securing insects from birds. *Amer. Nat.*, 1899, vol. 33, p. 461–484.

members had ever seen birds take butterflies. In the eastern United States there have been hardly more than a dozen published records of birds seen in the act of taking butterflies. Birds, so far as I have observed, seem to make no practice of giving chase to the butterflies that float about them as they busily catch other insects. Butterflies seem to be avoided, whether they are indifferently colored, protectively colored or mimetic, or warningly colored. It is said by Wallace that our milkweed butterfly is imitated by Basilarchia which thus escapes capture; but, as none of our butterflies are persecuted, it seems strange if mimicry has actually been aimed at. Beddard has shown that there are difficulties in the theory of protective mimicry from the fact that mimicking and mimicked forms are eaten, and that, in certain cases, instances of apparently useless mimicry occur."

In place of the theory of mimicry, a chemical theory of animal coloration may be substituted. Dr. Gadow has described pigments as physiological products of the organism, liable to chemical transformations with corresponding changes in color. Autumn leaves turn from green to yellow and red through such processes, and if a crimson leaf of the red maple resembles one of the Japanese ivy, it is not due to mimicry. What has occurred in *Basilarchia archippus* is a transformation from blue and black to a red like that of *Anosia plexippus*. A comparable change is found in *Semnopsyche diana*; the female is blue and black, but the male is brown and red. It may be noted also that *Speyeria idalia* has red fore wings, and hind wings chiefly blue, but that in the related genus *Argynnis* (in which *Speyeria idalia* was formerly included) both pairs of wings are red. Indeed the resemblance between *Basilarchia archippus* and *Anosia plexippus* is striking, but there is a similar resemblance between the Carolina locust and *Euvanessa antiopa*, and between *Basilarchia astyanax* and *Papilio troilus*. These are not accounted for by mimicry.

If mimicry does not explain the difference in color between the male and female of *Semnopsyche diana*, it may be doubted that the dark female of the yellow *Papilio turnus* in the south is a mimic of *Laertias philenor*. The latter, according to Weismann, is protected by its unpleasant taste and odor, but the odor as described by Comstock, is undoubtedly a perfume to attract and delight its mate. A. H. Pritchett (*Biol. Bull.*, 1903, vol. 5, p. 271–287) found that *Laertias philenor* was eaten by the lizard *Sceloporus floridanus* "with evident relish" in spite of its odor and the fact that its larva fed on the ill-tasting and poisonous Aristolochia. The lizard devoured the presumably immune *Anosia plexippus* also.

Piepers [1] describes the theory of mimicry as superstition and romance which "we still hesitate to abandon, particularly in England,— in *Nature* and the *Trans. of the Entom. Soc. of London* it abounds." From the English journal *Field*, he cites the account of an Egyptian butterfly, in which the hind end so resembles the head end that a bird will be unable to know which way the insect will attempt to escape! Similarly Bashford Dean, at the recent meeting of the American Society of Zoologists in New Haven, ridiculed rather than discussed the theory. He referred to the popularity of the Indian butterfly Kallima mounted as mimic of European beech leaves.

The resemblances between butterflies of diverse genera, many of which were known to the older naturalists, remain the interesting feature. Many American books, however, instead of describing them, present the theory of mimicry with the Anosia-Basilarchia illustration, and thus "touch only the fringe of a great subject."

F. T. LEWIS.

The Inheritance of Disease.— Professor Bateson, in his last lecture before returning to England, presented a considerable list of human abnormalities which are transmissible, perhaps in Mendelian proportions. Several of these pertain to the eye. Displacement of the lens due to an asymmetrical development of its ligament, is dominant; and also *praesenile cataract*, which occurs at birth or soon after. The largest tabulation of the transmission of abnormality through the descendants of one individual, was a case of inability to see normally except in bright illumination (*hemeralopia*). Color blindness and eye color,— pure blue being recessive — were also discussed. Diagrams were shown illustrating the transmission of hypertrophied skin of palms and soles; of the tendency to blister, known as *epidermolysis bullosa*; of *diabetes insipidus*; and of *haemophilia*, in which there is extensive bleeding from slight wounds. In the last condition males are much more often affected than females, although the apparently unaffected females belonging to the families involved may transmit the disease. This was compared with the inheritance of the horned condition in sheep. A hornless breed crossed with a horned form yields horned males and hornless females, these females transmitting the horns to the males; by further crossing with the horned stock, horned females occur also. Professor Bateson believes that

[1] Piepers, M. C. Noch einmal: Mimicry, Selektion, Darwinismus. Leiden, E J. Brill, 1907. 481 pp.

the results of experimental breeding will show how various human afflictions may be eliminated.

Dr. E. E. Tyzzer (*Journ. of Med. Res.*, 1907, vol. 17, p. 199–211) discusses the inheritance of tumors in mice. Although "the analysis of data derived from a large number of human cases has failed to furnish evidence that a predisposition to cancer is inherited," it is known that some races of mice are susceptible to transplanted tumors and that other races are not. In one of the susceptible races spontaneous tumors were found in four individuals in a family of twenty-six, there being one case in each of four generations. The data obtained are insufficient "to prove or disprove that the development of a tumor is dependent upon the presence of an inherited character, although they may appear to favor this view." Further experiments upon this vital subject are in progress.

Malaria in Ancient Greece and Rome.[1] — "Modern Greece is intensely malarious.... It has been estimated that in the unhealthy year 1905, out of a total population of only about two and a half millions, nearly a million people were attacked with malaria and nearly six thousand died." The three authors of the little book under consideration believe that malaria was introduced into Greece in the fifth century B. C. by "soldiers, merchants or slaves coming from Africa or Asia, the ancient homes of malaria." In the fourth century B. C., it became prevalent, and it is considered to be an important cause for the sentimentalism in art, pessimism in philosophy, and decay in morality characteristic of that century. "By 300 B. C., the Greeks had lost much of their manly vigor and intellectual strength.... Malaria made the Greek weak and inefficient; it turned the sterner Roman into a bloodthirsty brute." It was endemic in Rome probably from the second century B. C. It is implied that the modern atrocities of white men in tropical regions may be due in part to malaria; and attention is called to the immunity of Japan in contrast with the prevalence of malaria in China as an influence in modern history. The evidence for these propositions, as found in this book, will interest students of medicine, history, and the classics.

The Distribution of European Animals. — Dr. Scharff's well known *History of the European Fauna*, published in 1899 and critically dis-

[1] Malaria. A neglected factor in the history of Greece and Rome. By W. H. S. Jones. With an introduction by Major R. Ross and a concluding chapter by G. G. Ellett. London, Macmillan & Co., 1907. 108 pp.

cussed by Dr. Stejneger in the *American Naturalist* (1901, vol. 25, p. 87–116) has been followed by another book upon the same subject.[1] The problem of animal distribution is simply and clearly presented by means of outline maps on which the occurrence of a single species is plotted in black; in an unoccupied corner of each chart a picture of the animal is inserted. In a few cases the former land areas have also been indicated. Thus Fig. 6 shows a fresh water lake in place of the Irish Sea, from which the fresh water herrings (Coregonus) travelled up the streams to lakes in northern Ireland and western England and Scotland, where they are now isolated. Some of the charts deal with the distribution of plants, which are "subject to the same laws of dispersal as animals." Although "the occasional transport of species by wind or by marine currents has probably taken place sometimes," Dr. Scharff believes that it does not effect the constitution of an island fauna very materially. Twice he cites evidence that birds during migration do not have seeds in their crops or adhering to their bodies. Distribution is to be explained chiefly by geographical changes, and leads to such conclusions as that the Azores were not connected by land with America but only with Europe. The Canary Islands, however, "must have formed part of the land which connected Africa with America, in early Tertiary times."

Dr. Scharff believes that there was no "exceptional destruction" of the British fauna and flora during the glacial period. He is of the opinion that "the whole of the existing Irish fauna is of pre-glacial age" and that "a more uniformly humid climate of Europe may have favored the production of glaciers without decreasing the temperature." The criticisms of this hypothesis by Dr. Stejneger and others are noted by Dr. Scharff. The book is an admirable presentation of the purpose and importance of studies in animal and plant distribution.

The Dancing Mouse.[2]— Current publications have been so occupied with presenting and discussing faulty accounts of animal behavior that the public is scarcely aware of a science dealing with this subject. In a well written book entitled *The Dancing Mouse* Dr. Yerkes presents the methods and some of the results of this study. The dancing mouse, as described in the first chapters, is a domesticated animal of

[1] Scharff, R. F. European animals: their geological history and geographical distribution. New York, E. P. Dutton & Co., 1907. xiv+258 pp., 70 figs. $2.50.

[2] Yerkes, R. M. The dancing mouse. A study in animal behavior. New York. The Macmillan Company, 1907. xxi+290 pp., 33 figs. $1.25.

unknown origin, characterized by its inability to move far in a straight line without whirling or circling about with extreme rapidity. Its action may be compared with that of a cat in chasing its tail and regarded as an aimless, useless habit increased by the breeder's selection; or it may be considered an abnormal condition. Since this mouse cannot be made dizzy by any contrivance, it has been described as anatomically defective, but according to Dr. Yerkes the anatomical defects are not established and he "can see no satisfactory grounds for considering the dancer either abnormal or pathological."

The larger part of the book describes experiments with ingenious apparatus devised by the author for testing hearing, vision, educability, habit formation, efficiency of training methods, duration of habits, individual differences in behavior, and the inheritance of behavior. It is found that the dancing mouse, although able to squeak and capable of ear movements as if listening, is totally deaf except, in some instances, during the third week of life. The experiments indicate "that brightness vision is fairly acute, that color vision is poor, that although form is not clearly perceived, movement is readily perceived." The dancing mice learn some things of their own initiative, as how to use a swinging door which must be pushed on one side and pulled on the other; they are not helped by seeing other mice perform an act, but are aided by being put through it themselves. Certain acquired habits were remembered after from two to eight weeks of disuse; if forgotten, re-learning was easier. Initiative did not decrease with age up to eighteen months, the oldest studied. "Frequently my oldest mice have shown themselves preeminent in their ability to adjust their behavior to new conditions." Absolutely no evidence was found of the inheritance of an acquired habit, which in the case studied was beneficial to the animal.

These valuable studies in the mental life of the dancing mouse were accomplished without resort to vivisection. In place of depriving the mouse of its various senses, the apparatus was arranged so that they became inoperative. In methods as in results the work is highly commendable, and it has been awarded the Cartwright Prize of the Alumni Association of the College of Physicians and Surgeons, New York.

F. T. Lewis.

ZOOLOGY

Ichthyological Notes.[1] — *Fishes of Central America*: Mr. C. Tate Regan (in the Fauna Centrali- Americana, 1907) continues his account of the fishes of Central America, with good descriptions and a series of excellent figures.

He describes as new *Gerres simillimus*, the Pacific Coast representative of *Gerres* (or *Xystaema*) *cinereum*. He regards *Gerres axillaris* as distinct from *Gerres lineatus*. *Gerres embryx* and *Gerres brasilianus* are regarded as old examples of *Gerres plumieri*, a conclusion also reached by the present writer. He regards *Centropomus pedimacula* of Poey as identical with *Centropomus pectinatus*. The fish from the Pacific called *pedimacula* he identifies as *C. medius*. *C. mexicanus*, *C. gabbi*, and *C. heringi* are identified with *C. parallelus*. *C. argenteus* is the young of *C. undecimalis*. *C. viridis*, the Pacific representative of *C. undecimalis* is shown to be a distinct species. *C. affinis* and *C. scaber* are identical with *C. ensiferus* and *C. brevis* and *C. atridorsalis* with *C. armatus*. *C. altus*, a new species from Colon, is described as the Atlantic representative of *C. unionensis*. *Syngnathus spicifer*, a species from Zanzibar and the Philippines is recorded from Tehuantepec. *Doryichthys brachyurus*, a South Sea species, is recorded from Tehuantepec. *Siphostoma brevicaudum* from Vera Cruz, is regarded as identical with *Doryichthys lineatus*. *Chirostoma attenuatum* and *Ch. zirahuen* are regarded as identical with *Ch. bartoni*, and *Ch. mazquital* with *Ch. jordani*. *Chirostoma labarcae* is considered identical with *Ch. breve*, *Ch. crystallinum* with *Ch. lucius*, and *Ch. lermae* with *Ch. sphyraena*. The genus Melaniris is said to be founded on discolored specimens of Thyrina, and the species *evermanni*, *crystallina* and *balsanus* are all referred to the synonymy of *Thyrina guatemalensis*. Xenatherina, a new genus, is based on *Menidia lisa*. *Neomugil digneti* is identical with *Agonostomus nasutus*. *Joturus stipes* and *Agonostomus globiceps* are identical with *Joturus pichardi*. *Mugil gaimardianus* and *Mugil setosus* are regarded as the young of *Mugil curema*. This view may be correct, but a study of specimens in the markets of Cuba gave me a contrary impression. The well defined and thoroughly tenable genera Encinostomus and Tylosurus are not adopted by Mr. Regan, a view for which no reasons are assigned.

[1] Owing to unavoidable circumstances the proof of these notes has not been revised by President Jordan.

Fundulus guatemalensis and *F. oaxacae* are identified with *F. punctatus*. Cynodonichthys is identified with Rivulus. *Cyprinodon latifasciatus* is identified with *C. boveinus*, and *C. elegans* and *C. eximius* are placed in the same synonymy. *C. californiensis* and *C. nevadensis* are identical with *C. macularius*. *Zoogenaticus miniatus* is regarded as identical with *Z. diazi* and *Z. maculatus* with *Z. robustus*. The species *dugesi* and *quitzoensis* are referred to Zoogoneticus, while *pachycephalus* and *punctatus* are removed from their provisional station in Actinia. Limnurgus is unwarrantably used instead of the much older, but unpleasant name of Girardinichthys, and *Characodon geddesi* is placed in the synonymy of *G. innominatus*. Chapalichthys is regarded as inseparable from Characodon.

Characodon ferrugineus and *eiseni* are identical with *Ch. variatus*. *Ch. garmani* is the same as *Ch. latevalis*. Skiffia is made a synonym of Goodea. *Characodon duitpoldi* and *Xenendum xaliscone* are referred to the synonymy of *Goodea atripinnis*. *Skiffia variegata* is the same as *Goodea lermae*. Pseudoxiphophorus is regarded as a subgenus of Gambusia. *Gambusia affinis* with its synonyms is called by the older name of *Gambusia gracilis*. *Pseudoxiphophorus pauciradiatus* is the same as *Gambusia jonesi*, and *Ps. retiaulatus* is *Gambusia bimaculata*. *Poecilia presidionis* is placed in Girardinus, which name is used instead of the prior Heteraudria which may be ineligible because no known species were assigned to it. *Heteraudria occidentalis* is placed in Poecilia. *Poecilia sphenops* is made to include *mexicana, thermalis, gillii, chisoyensis, dovii, vandepolli, arubensis, boucardi, butleri, limantoun, nelsoni* and *latipunctata*. *Platypoecilus variegatus* is referred to *Poecilia maculata*; *Mollienesia formora* is referred to *M. latipinna*; *Xiphophinus jalapae* is referred to *X. helleri*. A number of additional South American cat-fishes are recorded from Panama. *Aelunchthys nuchalis* is regarded as identical with *A. panamensis*, and *Ae.* (or *Felichthys*) *scutatus* from Panama and *Ae. isthmensis* from Colon are described as new.

Netuma vacula is referred to the synonymy of *Galeichthys planiceps*, and *Netuma clattena* to that of *G. Kessleri*; *G. azureus* to that of *G. guatemalensis*, and *G. xenauchen* to that of *G. lentiginosus*. *Galeichthys seemani* is made to include *G. jordani, G. gilberti* and *G. eigenmanni*; *G. guentheri* is described as new, from the Gulf of Mexico.

The name Anus is used in place of the uncertain Tachysurus, probably with justice. *Galeichthys aquaedulce* is referred to *Anus melanopus*, *Tachysurus Steindachneri* to *Anus fuerthi*, *Tachysurus emmelane* to *Anus multeradiatus* and *Cathorops gulorus* to *Anus hypophthalmus*.

The same fauna is again treated by Dr. Seth E. Meek (Publ. Field Columbian Museum) in a Synopsis of the Fishes of the Great Lakes of Nicaragua. *Rhamdia barbata* is described as new from San Francisco de Nicaragua, and *Astyanax nasutus* from Managua. *Tetragonopterus humitis* is the young of *Astyanax aeneus*. *Bramocharax elongatus* is described from Lake Managua, and *Dorosome chavesi* from several localities. *Poecilia dovii* is the same as *P. sphenops*. *Melaniris sardina* is described from Lake Managua, and *Pomadasis grandis* from Lake Nicaragua. Erythrichthus is a new sub-genus based on *Heros citrinellus*. This name should be criticised as badly formed, while the name properly spelled (Erythrichthys) is already used for a genus of fishes. Dr. Meek gives an interesting account of the phenomenon of rubrism — the prevalence of red colors in part of the individuals of these fishes. *Cichlasoma granadense* is a new species from various lakes. *Cichlasoma dorsatum* is another from Lake Managua and *C. nigritum* from Lake Nicaragua. *Heros basilaris* is the same as *C. citrinellus*, the type of Erythrichthus.

Fishes of California: In the University of California publications (Marine Laboratory of San Diego) Edwin C. Starks and Earl L. Morris of Stanford University give a list of the Marine Fishes of Southern California. In this well considered list, the range of numerous northern species is extended to the south of Point Concepcion. The single new species is a flounder, *Pleuronichthys ritteri*.

Fishes of South America: In the Proceedings of the Washington Academy of Sciences (VIII, 1907) Dr. Carl H. Eigenmann gives notes on a Collection of Fishes from Buenos Aires. The fauna is essentially that of the Amazon, although the region is not tropical. New species are *Plecostomus laplatae*, *Pomolobus melanostomus*, *Geophagus australis* and *Batrachops scotti*. The use of the family name Stolephoridae is unexplained. The type of Stolephorus is identical with that of Spratelloides and the genus belongs to the Dussumieriinae.

In the Annals and Magazine of Natural History (XIX, 1907) Mr. C. Tate Regan describes *Pimelodus boucardi* from Yucatan; *P. brachycephalus* from Guatemala; *P. rogersi* from Costa Rica; *Gambusia annectens* from Costa Rica; *G. terrabensis* from Costa Rica, and *Sicydium pittieri* from Costa Rica. *Mollienesia jonesi* (= *Pseudoxiphophorus pauciradiatus*) is identified as *Gambusia jonesi*.

In the Proc. U. S. Nat. Mus. (XXXII, 1907) Dr. Eigenmann discusses the poecilioid fishes of the La Plata Basin. New genera are

Acanthophacelus (*reticulatus*), Ilyodon (*Ilyodon paraguensis*, new species), Phalloptychus (*januarius*) and Phalloceros (*caudomaculatus*). Jenynsia is not distinct from Fitzroya.

In Archivos do Museo Nacional (Rio de Janeiro, 1907) Dr. Alipio de Miranda Ribeiro begins an elaborate account of the fishes of Brazil. The first part is devoted to morphology and physiology. The work is well done, well printed, and with good illustrative plates.

In the Ann. Mag. Nat. Hist. (XIX, 1907) Dr. G. A. Boulenger discusses the variations of *Stercolepis gigas*, "a great sea-perch from California and Japan." He maintains that the two essential points of distinction, the higher spines and the larger scales in the Japanese form, *Stereolepis ischinagi*, as compared with the Californian *S. gigas*, are both fallacious. The spines are much higher in the young fishes, and the scale count is deceptive.

I am still of the opinion that the two are distinct. The smallest specimen of Stereolepis known from Japan or California was taken by me at Santa Barbara in 1880. This has much higher spines than the adult, but the spines are still lower than in *S. ischinagi* of much larger size. In my way of counting the scales are smaller. Moreover, the young of the Japanese species have broad lengthwise stripes of black, while the American form is irregularly blotched. A study of many specimens of different ages is necessary before the question can be finally settled.

Fishes of Bermuda: In the Bulletin of the Museum of Comparative Zoology, Thomas Barbour gives notes on Bermudian Fishes, with numerous additions to the list. *Siphostoma dendriticum*, a pipe fish covered with filamentous appendages, is described from Ireland Island. *Callionymus bermudanum* is dredged off Castle and Ireland Islands. *Antennarius stellifer* is described from Castle Harbor; *Teuthis helioides*, a species of bright yellow color, is from Castle Sound, and *Holocentrus puncticulatus* from Flate's Inlet.

Fishes of the South Seas: In the Report of the Bernice Pauahi Bishop Museum of Honolulu (IV, 1906), Mr. Alvin Seele records the fishes obtained in his extensive collections in the South Seas, from the Marquesas to the Solomon Islands. The new species, 33 in number, are represented rather unsatisfactorily by photographs.

In the same report (vol. II) is a paper by William A. Bryan describing three new species of fishes from Honolulu. One of these, *Zanclus*

ruthiae is distinct from *Zanclus cornutus*. It is, however, identical with the original *Zanclus canescens* recently newly described by Mr. Regan. The other species are *Pseudoscarus heliotropinus* and *Pseudoscarus vitriolinus*. Some of the parrot-fishes previously known from Hawaii are here again described.

In Bull. Dept. Agric., Indes Neerl. (VIII, 1907) Dr. P. N. Van Kampen describes East Indian mackerels, *Scomber kanagurta*, which he identifies with *S. loo*, *S. neglectus* and *S. brachysomus*.

In the same bulletin, Dr. Van Kampen describes a new shark, *Galeocerdo fasciatus*, from the East Indies.

In the Sitzungsberichte of the Gesellschaft Naturforschender Freunde Dr. Erich Philippi notes that the cyprinodont Glaridichthys is really physoclistous, not physostomus as is supposed to be the case throughout that family. He notes also that this viviparous genus does not have a modified anal fin in the male as has been supposed, a fact already noted by Dr. Meek. The other articles are notes on the genera Glaridichthys and Cnesterodon.

In the American Journal of Anatomy, 1907, Dr. Charles R. Stockard notes the embryonic history of the crystalline lens of the California hagfish *Eptatretus stouti*, which Mr. Stockard calls by the much later name of Bdellostoma.

In the National Geographical Magazine for June, 1907, Dr. Hugh M. Smith has an article on "Our Fish Immigrants" and Dr. Gill discusses Fish that Build Nests, with a series of interesting plates.

In the Pacific Fishermen for September, 1907, Mr. Henry S. McGowan discusses the destruction of young salmon by trout. and gives photographs of stomach contents which show that in all probability the trout in the northwestern streams kill as many salmon as the fishermen, taking them when very young.

Jordan and Evermann have already shown the enormous destruction of young salmon wrought by the Dolly Varden trout (*Salvelinus malma*) in Alaska. These photographs show that the steelhead and cut throat trout are also great offenders in this regard.

Fishes of Japan: In the Proc. U. S. Nat. Mus. (XXX, 1907) Jordan gives a review of the Japanese species of Histiopteridae or boar-fish. New genera are Evistias (*acutirostris*), Zanclistius (*elevatus*), Quinquarius (*japonicus*) vice Pentaceros preoccupied, Gilchristia

(*richardsoni*) and Quadrarius (*decacanthus*). The name Velifracta is substituted for Tephritis, a genus of flounders, the latter name being preoccupied. In the same proceedings, Jordan gives a review of the Japanese Gerridae, and Jordan and Starks a list of the fishes of the Riu Kiu or Lu Chu Islands, called Okinawa in Japan. One new species, *Girella mezina*, is described. The genus Hierichthys is identical with Congrogadus.

Fishes of Siberia: In the Proc. U. S. Nat. Mus. (XXXII, 1907), Dr. Leo Berg of St. Petersburg discusses the cobitoids and the sticklebacks of the Amur region. He regards the Asiatic loach, *Misgurnus anguillicaudatus*, as a color variation of the European *Misgurnus fossilis*, the former being irregularly spotted, the latter with longitudinal stripes. He further regards all the Asiatic specimens, *Ussuria leptocephala* Nikolsky, *Misgurnus decemcirrosus* Basilewaky etc. as variants under *M. anguillicaudatus*.

Octonema (preoccupied) and Lefua (Herzenstein 1888) are older names for the genus called Elxis by Jordan and Fowler, 1903. The Japanese species is *Lefua nikkonis*. *Elxis coreanus*, *Nemacheilus dixoni* and *Octonema pleskei* are regarded as synonyms of the Mongolian species *Lefua costata*. *Orthrias oreas* from Hokkaido, Berg regards as identical with *Nemacheilus toni* from the Amur, and he thinks it is not generically and scarcely specifically different from the European *N. barbatulus*. Like Jordan and Fowler, Berg finds the common loach, *Cobitis taenia*, identical in Europe, Siberia and Japan.

The Japanese stickleback, *Pygosteus undecimalis*, is identical with *P. tymensis* (Nikolsky 1889) from Sakhalin; *Pygosteus seindachneri* and *P. bussii*, are as the present writer has already indicated, identical with *Pygosteus sinensis* from China.

Mosquito-eating fishes: In the Bulletin of the Hawaii Exp. Station, (20, 1907) Mr. D. L. Van Dine gives a valuable account of the successful introduction of Texas top-minnows, as natural enemies of mosquitoes. This was done at the instance of the present reviewer. The work was successfully accomplished by Mr. Alvin Seale under the auspices of the Honolulu Board of Health and of the Territory of Hawaii. The species secured were *Gambusia gracilis*, *Fundulus grandis* and *Mollienesia latipinna* from Galveston, Texas. 450 fishes were taken, 27 being lost on the way. All the species thrive in the new locality and all are eager in the destruction of mosquitoes, the little Gambusia perhaps most so.

Fishes of South Africa: Dr. J. D. F. Gilchrist (Marine Investigations in South Africa, 1907) describes 15 new species of fishes, some of them of special interest. Dr. Jacques Pellegrin (Assoc. Française Avanc. Sci., 1906) notes the presence of a genus of Asiatic family of Nandidae (Polycentropsis) in Africa (Rio Niger).

Fishes of New Guinea: In Resultät. Exp. Sci. Neérl. à la nouvelle Guinée (Leiden, 1907) Dr. Max Weber describes the fresh water fishes of New Guinea with many new species. This is an excellent paper, well illustrated.

Fishes of the Antarctic: In the Expedition Antarctique Française (Paris, 1907) Dr. Léon Vaillant describes the fishes, with several new species. A genus, Artedidraco, commemorates the 200th anniversary of the birthday of the "Father of Ichthyology," Petrus Artedi.

In Illustrations of the Zoology of the *Investigator* (Calcutta, 1905), Alcock and MacGilchrist figure deep sea crustaceans and fishes already described.

In the Sitzungsberichte of the Academy of Vienna (1907, XXVIII), Dr. Steindachner describes a number of fishes from Jurua, Brazil, and in two other papers, other species from streams of southern Brazil, the greatest number being from Rio Cubatao.

Dr. Louis Dollo (Proc. Royal Soc. Edinburgh, XXVII, 1907) notes the rediscovery of a singular pelagic fish, *Prymnothonus hookeri*, which he regards as an ally of Paralepis.

Mr. J. Douglas Ogilby in the Annual Report of the Amateur Fishermen's Association of Queensland (Brisbane 1907) gives a list of the species of fishes in the collection, with new generic names, undefined, but with indicated types as follows: Batrachomoeus (*coecus* DeVis) "the Greater Frog-fish," Brachaelurus (*colcloughi*, new species) the "Blue Gray Blind-shark," Coryzichthys (*diemensis* Le Sueur) the "Banded Frog-fish." These were described in a paper read March 23, 1907, but the accounts have not yet appeared. A number of new species to be described are also indicated, the types being in this collection.

In the Records of the Canterbury Museum (1907, I) Mr. Edgar R. Waite gives a list of the fishes of New Zealand, 252 species are recorded. This figure shows how far from complete is our knowledge of New Zealand fishes. It is safe to say that a thorough survey of these waters

such as Mr. Waite contemplates will yield double this number of shore-fishes, although the isolation of New Zealand is doubtless a reason why the fauna is relatively scanty as compared, for example, with that of Japan. The shore-fishes of New Zealand are for the most part distinct from those of Australia.

The writer has lately received through the courtesy of Mr. J. H. Tole of Auckland, a little known volume, Handbook of the Fishes of New Zealand, published by R. A. Sherrin, at Auckland in 1886. This book is largely a compilation, but an intelligent one.

In Zool. Anzeiger (XXVIII, 1905), Professor Robert Collett describes a number of fishes from the Azores, one of them, *Lampadena chavesi*, being new.

Dr. F. Guitel of Rennes publishes (Archiv. Zool. Exper. 1904) comparative descriptions of species of Lepadogaster the beginning of a general anatomical and systematic study of the Gobiesocidæ, in which he asks the cooperation of naturalists.

In the Smithsonian Miscellaneous Collections (1907) Dr. Theodore Gill gives an elaborate account of "Noteworthy Extra-European Cyprinids," a comparative study of dace, minnows, roach, horny-heads and shiners of America and Asia.

In another paper Dr. Gill gives an outline of the strange life-history of toad-fishes, weevers and stargazers, with plates.

Classification of Fishes: In Ann. N. Y. Acad. Science (XVII, XXIX, XXX, 1907) Dr. William K. Gregory of Columbia discusses the orders of teleostomous fishes. This is a peculiarly wise and temperate discussion of one of the most difficult of problems, the arrangement of the bony-fishes in tangible, definable and natural groups. Dr. Gregory recognizes that "degrees of blood relationship do not exactly correspond to degrees of homological structural resemblances and differences nor to the divisions of classification." He also recognizes that distinctness in groups is often dependent on the extinction of intermediate forms. He discusses in excellent fashion the strength and defects of the "English and American schemes of Classification," and shows that these are in fact nearer to each other than they appear. "The idea underlying the American method is that the best way to map out the topography of this varied morphological expanse is to assign a name to every conspicuous cluster of elevations, even if some lower elevations may connect with neighboring

systems." On the whole Gregory inclines to the American system and approves of "Gill's principle of keeping groups apart until they are shown to belong together." No linear series and no grouping of these fishes into orders and suborders can ever be satisfactory to anyone, for the forms in question exhibit a great variety of interrelations and divergences. The classification of Dr. Gregory is however about as satisfactory as any one which is current, and it represents a great amount of careful investigation and comparison.

Ecology of Fishes: In the Journal of Geology (1907) Dr. John C. Branner discusses the coastwise streams about Monterey Bay, with reference to present distribution of the fish fauna. He shows that the latter is dependent on the former courses of these streams.

In the Bull. Bureau of Fisheries (XXVI for 1906) Prof. Chauncey Juday gives an elaborate study of the Twin Lakes in Colorado, with especial reference to the food of the trout, *Salmo stomias*.

In the Rept. of the Director of the New York Aquarium, Mr. Charles H. Townsend, discusses the cultivation of fishes in ponds.

Anatomy of Fishes: In the Biological Bulletin (XII, 1907) Dr. H. D. Senior discusses the conus arteriosus of two of the most primitive of bony fishes, *Tarpon atlanticus* and *Megalops cyprinoides*, with comparison with that of other related forms. In Albula, Tarpon, and Megalops there are two rows of valves. Ordinary bony fishes have but one, while in the ganoid fishes, there are three (Amiatus) or more. In Elops, Chanos, Hiodon, Osteoglossum, Notopterus and Mormyrops, but one row of valves has been found. In Dorosoma, there is a trace of a rudimentary second row. This strengthens the suggestion that the Megalopidae, (Megalops, Tarpon) should constitute a family distinct from Elops.

In the Proc. Wash. Acad. Sciences, 1907, Mr. W. F. Allen of Stanford University discusses very fully the distribution of the sub-cutaneous vessels of the head in the gar pike and paddle fish.

In the Budgett Memorial Volume (Cambridge, England), Dr. J. Graham Kew of the University of Glasgow, discusses with great completeness the embryology of the crossopterygian fish, *Polypterus senegalus*. In this paper, Dr. Kew upholds his theory as to the origin of the vertebrate limb from modified gills rather than from a lateral fold or from a gill septum.

In the Journal of Experimental Zoology (IV, 1907), Mr. Charles R. Stockard discusses the influence of external factors, chemical and physical on the development of the egg of the killifish (Fundulus).

Fossil Fishes: In the Bull. of Geology of the University of California, Dr. D. S. Jordan describes the fossil fishes known from the rocks of California, with supplemental notes on other extinct fishes. 43 species are known from California. *Acrodus wempliae, Heptranchias andersoni, Isusus smithii, Carcharodon arnoldi, C. riversi* and *C. branneri, Xenesthes velox, Etringus scintillans, Rogenio solitudinis* and *R. bowersi*, and *Merriamella doryssa* are described as new. Xenesthes, Etringus, Rogenio and Merriamella are new genera. Rogenio, a new genus, doubtfully referred to the Cobitopsidae, shows a remarkable resemblance to the New Zealand white bait, Retropinna, and is possibly a fossil smelt. Etringus is a curious form with enamelled ganoid scales, and the body of a herring. Merriamella seems to be an athenoid with a small spinous dorsal fin.

The genus Knightia (*K. eocaena*) from the Green River Eocene is characterized, and also a new species of sucker, *Chasmistes oregonus* (Starks) from Oregon. Teeth of fossil salmon from the Quaternary of Oregon show the extreme age of the anadromous habit of the salmon of the Columbia.

In the Memoirs of the New York State Museum (X, 1907), Dr. Charles R. Eastman presents an elaborate monograph of the Devonic fishes of the New York formations, with a series of excellent plates. Interesting discussions of the relationship of Bothriolepis and other ostracophores is given, the author regarding these forms as a distinct class, but not accepting the recent bold speculations of Dr. William Patten, who compares these forms with Limulus and other spider-like crustaceans.

Mr. George P. Merrill publishes a catalogue of the fossils, minerals and ores in the United States National Museum (1907). This catalogue furnishes a useful list of the fossil fishes. All the California species above noted — even the abundant sharks' teeth — seem to be wanting in the national collection.

In the Bulletin Mus. Comp. Zool. (vol. L, 1907) Dr. Eastman discusses the dentition of the mylostomid Arthrodires, giving further reasons for regarding the Arthrodires as specialized Dipnoans. A new species is described from the Cleveland Slate, as *Mylostoma newberryi*.

In the Bulletin Amer. Mus. Nat. Hist. (XXIII, 1907), Mr. L. Hussakof describes a fossil surgeon-fish from Antigua Island, West Indies, in rocks supposed to be of Eocene Age. The species, represented by a very complete skeleton is named *Zebrasoma deani*. This species is the first of the family of Hepatidae (Teuthidae) found in America, and it is the only fossil species of the genus Zebrasoma. The pertinence of the species to the living genus Zebrasoma may be questioned. The first dorsal spine is the longest and seems semi-detached. In Zebrasoma the first is much shorter than the others. The soft fins in Zebrasoma are very high. In Z. deani, they are quite low. The caudal peduncle is slenderer in *Z. deani* and the tail much more widely forked than in any species of Zebrasoma. The number of vertebra (8 + 11 = 19) is fewer than in living Hepatidae (22). The caudal spine possibly existed, but if so, it is lost in this specimen.

If the fish is to be referred to an existing genus, Callicanthus with a slender tail and a widely forked fin, with the first of the five dorsal spines enlarged and with the vertical fins low, is nearer to the species than is Zebrasoma. The profile in Callicanthus is curved while in *Z. deani*, it is very straight.

In the Bulletin de la Societé Belge de Geologie (XXI, 1907), Dr. Louis Dollo endeavors to show that the ptyctodont fishes, supposed to be fossil chimaeroids, really belong to the order of Arthrodires. He further concludes that the chimaeras are specialized cochliodonts, changed through the necessities of deep sea life and a food of mollusks. Dr. Dollo further adds that "the idea of the Irreversibility of Evolution which has led me to the conclusions I have just justified, has once more shown its utility, else one would be led to maintain that specialized organisms might become in the process of descent again primitive, in order to become again specialized in the same or in different direction."

DAVID STARR JORDAN.

Notes on the Structure of Insects.— *A Study of the Common House-Fly.*[1] — That one need not search far for profitable objects of research is evidenced by the mass of interesting material presented by Mr. C. H. Hewitt's studies of the common house-fly, *Musca domestica*. In the first of a series of three papers dealing with the anatomy, develop-

[1] Hewitt, C. G. The structure, development, and bionomics of the house-fly, *Musca domestica*. Part 1.— The anatomy of the fly. *Quar. Journ. Micr. Sci.*, 1907, li, pp. 395–448, pls. 22–26.

ment, and bionomics of the species, is considered especially the anatomy of the adult.

Various species are popularly confused with *M. domestica* and the author therefore discusses the characters by which this — the true "house-fly" — may be distinguished. External anatomy is then considered and an attempt is made to homologize the various sclerites with those already recognized in the simpler orders of insects. Most of the terms introduced by Lowne are discarded and a number of inaccuracies in his descriptions are corrected. In the discussion of the wing veins the Comstock-Needham nomenclature is adopted since, "on account of its great morphological value it will no doubt in course of time replace the present confused system." By an oversight the free parts of M_3 and of Cu_2 are referred to as the medio-cubital and the cubito-anal cross-veins respectively.

Macroscopic features of the internal structure are described in detail, though there is little discussion of the histological features. Especially detailed are the accounts of the tracheal system, and of the musculature. The four double plates illustrating the anatomy are well executed, but the plate illustrating the imagos of *Musca domestica* and related species is too highly colored.

The Segmentation of the Insect Head.— Holmgren[1] discusses the moot question as to the number of segments in the head of the dipterous larva. In opposition to Bengtsson '97 and '05, he maintains that the suboesophageal ganglion includes but three segments. In support of his contention that the endolabium represents a separate segment, Bengtsson has cited; 1, — an independent innervation from the suboesophageal ganglia and certain suggestive structural relations of this part; 2,— the development; and 3,— comparison with other forms.

Holmgren shows that the so-called endolabial nerves of Bengtsson are muscles, as is most clearly brought out in thin sections treated with iron-haematoxylin. The slight elevation which was supposed to represent a distinct ganglion in the sub-oesophageal complex is caused by the contraction of the muscles. Postembryonic development cannot decide the question, for the presence of a fourth pair of imaginal discs with peripodal cavities does not prove that these are homodynamous with legs, and therefore with the mouth parts (cf. origin of eyes or wings).

Finally, Holmgren maintains that evidence drawn from Folsom's

[1] Holmgren, N. Zur Morphologie des Insektenkopfes. *Zool. Anz.*, 1907, Bd. xxxii, pp. 73–97.

discovery of a fourth segment in the suboesophageal ganglion of Anurida is entirely useless since the endolabium of Phalacrocera larva is not homologous with the paraglossae of the Thysanura.

The Habits and Structure of a Myriapod.— S. R. Williams[1] presents many new observations on the habits and structure of the interesting myriapod, *Scutigerella immaculata*. Its distribution, environment, light and water relations, and food habits are discussed. Experimental evidence favors the conclusion that the species is carnivorous. There is also presented considerable data regarding the eggs and the larvae. The newly-hatched larva has seven pairs of legs while the adult has twelve pairs. The author regards it as a highly specialized young, rather than a generalized ancestral form such as the hexapod larva of other diplopods is considered to be.

Musical Organs of the Cicadidae.— Among the most remarkable and effective voice-organs of the entire animal kingdom are the "drums" at the base of the abdomen of the males of the "seventeen-year locust" and their relatives in the family Cicadidae. It would seem that for these insects any other musical apparatus would be superfluous but Jacobi,[2] '07, reports finding in the cicadid genus Tettigades, from Chili, stridulating organs very similar to those already reported for certain beetles, ants, and other forms. They consist of a pair of oval, roughened file-like areas on the dorsal part of the prothorax, just within and caudad of the bases of the front wings. On the caudal angle of each front wing is a thickened flap which serves as a scraper. Unlike the abdominal musical organs these stridulating organs are equally developed in both sexes.

W. A. RILEY.

British Rhizopods[3]— No group of organisms affords quicker or more satisfactory returns to the amateur microscopist than do the fresh water Rhizopoda, and few offer to the specialist greater opportunities for experimentation and investigation or more puzzling problems in the determination of species and the tracing of life histories.

[1] Williams, S. R. Habits and structure of *Scutigerella immaculata*. *Proc. Bost. Soc. Nat. Hist.*, 1907, xxxiii, pp. 461–485, pl. 36–38.

[2] Jacobi, A. Ein Schrillapparat bei Singcicaden. *Zool. Anz.*, 1907, xxxii, pp. 67–70.

[3] The British Freshwater Rhizopoda and Heliozoa. By James Cash and John Hopkinson. Vol. I. Rhizopoda. Part I. 150 pp. 16 Plates. London 1905.

It is therefore a matter of congratulation to all who are interested in this inviting field to learn that Messrs. Cash and Hopkinson have undertaken the preparation of a monograph of the Rhizopoda and Heliozoa of the British Isles. Penard's exhaustive treatises upon these organisms of the Swiss lakes have provided continental Europe with a very complete account of these protozoans and the present work aims at a similar analysis of the British fauna. The first volume includes the order Amoebina and a small part only of the Conchulina, proposed by the author in place of the Testacea of M. Schultze. In all, 17 genera and 46 species are described. The work is illustrated with well-executed lithographic plates and numerous text-figures, and is provided with very complete bibliographic and synonymic references, supplementing in these respects the more detailed and extensive works of Penard. The fullness of the bibliographic lists is shown by the fact that the references under *Amoeba proteus* occupy five closely set pages.

The introductory chapter discusses briefly the structure and activities of the rhizopodan cell and the structure and method of formation of the test. The discussion of the distribution and known habitats of the various genera and of the best methods of collecting rhizopods is both instructive and helpful. We note the revival of Leidy's genus Ouramoeba founded on individuals bearing a peculiar filamentous appendage. Professor W. L. Poteat has shown[1] that these supposed appendages are merely the mycelial hyphae of some parasitic fungus, a view which Penard also subsequently adopted. The authors seem not to have been aware of Poteat's work.

C. A. Kofoid.

BOTANY

Recent Studies on Gymnosperms.— Among the numerous recent contributions to our knowledge of the gymnosperms several are of more than usual importance. These deal with all the four orders and include work both on living and on fossil forms.

The discovery of spermatozoids in the cycads in 1896, and of those of Gingko at about the same time by the Japanese botanists Ikeno and Hirase, and shortly after Webber's studies on Zamia, gave a great impetus to the investigations on these very important plants, and our

[1] Poteat, W. L. Leidy's Genus Ouramoeba. *Science*, N. S. vol. 8, p. 778–782.

knowledge of these forms has been very materially increased during the past decade.

Among the most important of the more recent papers are those of Chamberlain (The Ovule and Female Gametophyte of Dioon. C. J. Chamberlain. *Bot. Gaz.*, XLII, Nov. 1906, pp. 322–358. Pls. XIII–XV. Preliminary Note on Ceratozamia. Ibid., XLIII, Feb. 1907, p. 137) and that of Caldwell on *Microcycas calocoma* (Microcycas Calocoma. O. W. Caldwell. *Bot. Gaz.*, XLIV, Aug. 1907, pp. 118–141).

The three genera treated in these papers are all peculiar to America. Dioon and Ceratozamia being Mexican, while Microcycas is confined to a limited district in the western part of Cuba.

Professor Chamberlain made careful studies in the field, where he collected a good deal of material, but his studies also included living material sent to Chicago from the region where Dioon grows. The latter is abundant in a region about twenty-five kilometers from Xalapa, the capital of the state of Santa Cruz. Apparently Dioon is confined to this very limited area. The plant much resembles Cycas, but does not attain the dimensions of *C. revoluta* or *C. circinalis* as these occur in their native habitats. The largest specimen seen had a height of only three meters; but nevertheless it was estimated that these plants were at least one thousand years old. The growth is excessively slow, and a careful study of the rate of growth of plants in cultivation has led to this extraordinary estimate of the age of the larger plants.

The plants are said to fruit freely every other year. The ovulate cones are very large, sometimes weighing six kilograms or more, and the large size of the sporophyll approximates that of Cycas, although the sporophylls are arranged in a definite cone. The lower leaves of the cone are sterile and there are intermediate forms between these sterile leaves and those that bear the ovules. Each perfect sporophyll bears two very large ovules, which may reach a length of four centimeters. The ovules do not ordinarily attain their full development unless pollination takes place.

Full details are given of the methods used in studying the development of the ovule and there is also a complete account of its morphology. The question of the possible double nature of the integument is left unsettled.

At the time of pollination there is a considerable amount of tissue at the apex of the nucellus, above the embryo sac; but later this is destroyed, partly by the growth of the pollen tubes and embryo sac,

and unquestionably the pollen tubes come into direct contact with the archegonia. A pollen chamber is present as in the other cycads, immediately after pollination. A very conspicuous jacket surrounds the endosperm, and the megaspore membrane is easily identified. The walls of these jacket cells are strongly suberized. The jacket cells seem to be concerned with the nutrition of the endosperm.

Unfortunately the younger stages of the gametophyte could not be secured. The earliest ones collected in November already had the initials of the archegonia developed. The development of the latter is probably not essentially different from that of Cycas. The prothallium is fully developed in April and at this time the archegonial chamber is complete. The megaspore membrane becomes thick and shows the clear differentiation into an endospore and exospore as in the heterosporous pteridophytes.

The archegonia are enormously large and there may be as many as ten present. As in the other cycads that have been investigated, there are two neck cells. A ventral canal cell nucleus is separated from the very large egg nucleus. The number of chromosomes was estimated to be twelve. The egg may reach a length of six millimeters, and the nucleus is correspondingly large, in some cases being as much as 600μ. in diameter. In spite of this enormous size, the nature of its minute structure was not satisfactorily made out.

The paper is accompanied by several excellent photographs and by three plates.

Chamberlain's second paper is a preliminary note on the Mexican genus Ceratozamia. This differs much in its habitat from Dioon, being a shade-loving form, while Dioon is markedly xerophytic. Fertilization was found to occur more than a year subsequent to pollination. Motile spermatozoids resembling those of Cycas and Zamia were seen. The seed has no resting period, but growth is continuous from the time of fertilization to the emergence of the young sporophyte from the seed.

Professor Caldwell's paper on *Microcycas calocoma* is a very interesting account of a little known cycad from the sierra of western Cuba.

In habit, the plant recalls *Cycas revoluta*, and like that species shows various forms of branching. The largest specimens attained a height of more than nine meters.

The ovulate cones are the largest yet known. One of these measured ninety-four centimeters in length and weighed nine and five tenths kilograms. The staminate cone is much smaller.

The most important discovery made was the remarkable character

of the male gametophyte, which is the most primitive yet discovered among the seed bearing plants. The fully developed pollen tube contains a prothallial cell, a tube nucleus, stalk nucleus and eight body cells, each of which develops two large sperm cells, thus giving rise to sixteen large spermatozoids similar to those known in several other genera of cycads. In exceptional cases as many as ten body cells were noted. Whether, as seems probable, the eight body cells are formed from the division of a primary one was not determined. The male gametophyte of Microcycas is thus seen to be less reduced than that of some heterosporous pteridophytes, *e. g.* Isoetes, Salvinia, Azolla, while no other living seed plant is known to show more than two generative cells, unless possibly Araucaria, where a large number of nuclei have been reported in the pollen tube, the exact nature of which, however, is somewhat problematical.

The development of the female gametophyte was not followed in detail, but it was found that the number of archegonia is very large, sometimes exceeding two hundred. So far as could be determined, the archegonium is of the same type as that of the other cycads.

The ripe seed contains a single large, straight embryo, with three to six cotyledons. The young plant produces a tuberous stem several centimeters in length before the first true leaf emerges. The author concludes that Microcycas is the most primitive of all the known cycads. The paper is illustrated by a number of excellent photographs and there are three plates showing the most important points in the development of the gametophyte.

The remarkable series of fossil cycads from different regions in the United States, but especially from the Black Hills of Wyoming and South Dakota has been exhaustively treated in the magnificent memoir by Wieland (American Fossil Cycads. G. R. Wieland. Carnegie Institution of Washington, No. 34, 1906). Space will not permit a complete review of this volume, which comprises nearly three hundred quarto pages, with fifty plates and many text figures. The work is mainly based upon the great collections in the museum of Yale University, the most important collection of fossil cycads in existence.

The introductory chapter deals with the discoveries and collections of fossil cycads in Europe and America. The second chapter treats of the preservation of the fossil forms and discusses at length the external characters of living cycads. A number of admirable figures are given, including some of the curious culture forms of *Cycas revoluta*, which is a favorite with Japanese gardeners. Some of these garden forms are curiously like many of the fossil cycad trunks. An interest-

ing account is given of the methods used in cutting sections of the petrified trunks. Tubular drills were employed to cut out solid cores for studying fruits, etc. These cores were then sectioned in the desired directions. In this way the trunks could be fairly well preserved.

Chapter four is concerned with the structure of the trunk, both the external layer, which is mainly composed of large, closely packed scales, "ramentum," and the internal structure, which is often preserved in a very perfect way and makes the structure of the trunks perfectly clear. For details the reader must be referred to the memoir.

The leaves of the fossil cycads have been preserved in many instances in a remarkably perfect manner, even the young unfolded leaves being clearly evident in some specimens. This is particularly the case in one species, *Cycadeoidea ingens*. The young leaves were apparently quite similar to those of Dioon or Macrozamia. As is the case with the stem, the internal structure of the leaves is also perfectly preserved.

It is the reproductive parts of these fossil cycads, however, that are of the greatest interest. While some of these are of the same type as those of the living cycads, one group, sometimes separated from the true cycads as a special order, Bennittitiales, had bisporangiate cones, which apparently were curiously like the flowers of certain angiosperms. Some of these have been preserved in a wonderfully perfect manner owing to the young cones being completely protected by the armor of scales in which they were imbedded. The "flower" consists of a central conical receptacle which bears slender sporophylls, each one terminating in a single ovule. Surrounding this ovulate receptacle was a series of pinnate microsporophylls, each one bearing a large number of "synangia," extraordinarily like those of the fern Marrattia. Surrounding the whole strobilus was a series of elongated scales or bracts very much like the floral envelopes of certain angiosperms.

The type of cone shown in these Bennettiteae is much more specialized than that of the living cycads, but it is questionable whether the resemblance to the angiospermous flower is anything more than a coincidence. Nevertheless in the search for the ancestors of the prevailing type of seed plants, one is tempted to assume an actual relationship between these and the Cycadeoideae.

The preservation of the seeds is also very perfect, and in some cases dicotyledonous embryos can be recognized within the petrified seeds. Some of the specimens of the young ovules were very perfectly preserved and these showed what seemed to be prothallial structures suggesting those of Gingko. More evidence, however, is necessary before it can be certainly decided what was the process of the development of the

prothallium and embryo. The species in which the bisporangiate cone is best shown has been named *Cycadeoidea dakotensis.*

In chapter nine there is given an excellent comparison of the existing and fossil cycads. There are but one hundred and seven described species of living cycads, included in nine genera, of which four belong to the New World and five to the Old World (including Australia). As we have seen in the consideration of Chamberlain's and Caldwell's papers, three of the four American genera are of very limited distribution, Zamia being the only American genus of fairly extended range. Three of the Old World genera, *i. e.* Cycas, Encephalartos and Macrozamia, are much more widespread. As is well known, the cycads were a predominate plant type during most of the Mesozoic, when this type reached its culmination.

The affinities of the cycads with ferns have been long recognized and Wieland's work strongly confirms the view that these have arisen from ferns of marattiaceous affinity. The extraordinarily Marattia-like microsporangial sori of Cycadeoidea are especially striking in this connection. Wieland discusses the question whether the Cycadeoideae, that is, those forms with bisporangiate cones, should be separated as a special order, Bennettitiales, as recognized, among other authorities, by Engler and Prantl. This view is not accepted by all botanists however, some of whom, like Scott, recognize three families, Cycadeae, Zamieae and Bennittiteae, all referable to a single order, Cycadales. This latter view is supported by Wieland, who believes that from the great complex of Cycadofilices or Pteridosperms (seed-bearing ferns) a group which is now known to have been highly developed during the Paleozoic, there arose the common ancestors of the true cycads and Bennittiteae, the group becoming more and more divergent as they developed through the Mesozoic. Of these two divisions, only the true cycads have survived to the present time.

The final chapter is taken up with a discussion of the relation of the cycads to the ferns and of the analogies exhibited between the flower of the Cycadeoideae and those of the angiosperms. The strong evidence that the Cycadales are descended more or less directly from marattiaceous ancestors is summarized, and after pointing out the numerous points of resemblance the author says: "Plainly the preceding résumé of the principal characters of the two great cycad groups as combined and showing their descent from marattiaceous ferns of the Paleozoic is not merely conclusive, but one of the great cornerstones upon which the plan of evolution can rest secure."

It is evident that having to deal with such an enormously compli-

cated plexus of forms as the ferns and pteridosperms of the Paleozoic, it is well nigh impossible to come to a definite conclusion as to the question of the common origin of the cycads proper and Cycadeoideae and the question of the possible relation of these on the one hand to the other gymnosperms, and on the other to the angiosperms. "It is believed in the Cycadeoideae and especially in the persistence in such highly organized plants of the marattiaceous synangium that we get the first unmistakable hint of the nature of angiosperm evolution and the further view would seem to be justified that while the staminate disc surrounding the ovulate axis of Cycadeoidea indicates primarily an evolution terminating, so far as now possible to trace, in the gymnosperms, the juxtaposition of parts is exceedingly suggestive of the possibility, if not the manner as well, of angiosperm development directly from filicinean forms."

The discovery that many of the supposed Marattiaceae of the Paleozoic are really seed-bearing plants, Pteridosperms, emphasizes the importance of the Marattiaceae as the ancestors of the higher seed-bearing types. Whether or not we may agree with all of the author's conclusions, this magnificent memoir must remain an indispensable source of information for every student interested in the fascinating problems of the origin of the higher plants.

The development of the ovule and female gametophyte in Ginkgo are treated in a recent paper by Miss I. E. Carothers (The Development of the Ovule and Female Gametophyte in Ginkgo. *Bot. Gaz.*, 43, pp. 16–130, Feb. 1907). The most important point brought out in the course of this study is the fact that a large amount of chlorophyll is developed in the tissues of the gametophyte. This seems to be the only instance known where the endosperm develops chlorophyll, except in the case of Cycas, where it has been found that under certain conditions the prothallium may grow out of the ovule and on exposure to the light may turn green. The paper is accompanied by two plates.

Among the most important of the recent papers on the development of the Coniferae may be mentioned two by Lawson (Gametophytes, Fertilization and Embryo of Cephalotaxus Drupacea. A. A. Lawson. *Annals of Botany*, XXI, 1907. The Gametophytes and Embryo of the Cupressineæ with Special Reference to Libocedrus decurrens. Ibid., XXI, Apl. 1907).

The first of these papers deals with *Cephalotaxus drupacea*. In this species the macrospore remains undivided until a very short time before it is shed, when it divides into two cells, the tube cell and the generative cell. No vestigial prothallial cells are present. After the

separation of the stalk nucleus from the antheridial cell the latter has its nucleus divided into two equal sperm nuclei, but there is no division wall formed between them. Both sperm nuclei enter the archegonium. Probably only one megaspore develops a prothallium. The membrane is almost wanting and in this respect as well as in some others the Taxaceae are regarded as less primitive than the other conifers. The development of the prothallial tissue follows the usual course found in the Coniferae. The archegonia, which are usually four in number, offer no marked peculiarities. There are two or three neck cells, and Lawson failed to confirm the statement of Arnoldi that the nuclei of the jacket cells pass into the egg cell, and he does not think that the "proteid vacuoles" of the egg have any connection with the nuclei of the jacket cells. A ventral canal cell nucleus is always found.

Of the two sperm nuclei that enter the egg only one is functional. After fertilization the fusion nucleus divides until eight free nuclei are formed. The next divisions are accompanied by cell walls. Only one embryo is normally formed from each archegonium. The embryo shows a more or less clear division into four tiers, of which the lowermost forms a cap over the apex of the embryo proper. Very long suspensor cells develop from the tier above the embryo proper and these push the embryo into the endosperm. Secondary suspensor cells are later developed from the upper part of the embryo itself.

The author's conclusions as to the systematic position of Cephalotaxus are as follows: "From this account of the gametophytes it becomes obvious that Cephalotaxus cannot be regarded as a primitive type of the Coniferae, although this is contrary to the results obtained from certain studies on the sporophytes. . . . . Worsdell regards Cephalotaxus as the most ancient of the coniferous genera and concludes that this genus forms in a measure the connecting link between the Cycadaceae and Coniferae. . . . . By comparing the gametophytes of Cephalotaxus with the Cycadales and with the Coniferales, I cannot accept Worsdell's view. In fact I am forced to the conclusion that this genus represents a very recent type of conifer."

In the study of the Cupressineae, Dr. Lawson has taken as the principal form for study the incense cedar, *Libocedrus decurrens*, of the Pacific Coast, one of the noblest members of the family. The material was collected from the fine collection of conifers growing upon the grounds of Stanford University.

Pollination occurs in *Libocedrus decurrens* as grown at Stanford late in March or early in April. Like the other Cupressineae the pollen spores are small and each contains two cells, the smaller one

being the generative cell, which afterward divides into a stalk and body cell. The latter produces two similar male cells and this seems to be the rule in the Cupressineae. No sterile prothallial cells such as occur in the Abietineae and Cycas have been found in any Cupressineae. The other genera, in which a similar division was observed. were Cupressus, Chamaecyparis, Thuja, Cryptomeria and Taxodium. Both of the latter, according to Lawson, show close affinity with the Cupressineae, with which, however, they are not usually associated. Libocedrus, in the history of the male gametophyte, approaches most nearly to Thuja.

Two megaspore mother cells are usually present and from each of these four megaspores arise. Only one of the latter, however, develops a prothallium, the others being apparently destroyed by its further growth. The megaspore in its earlier stages of growth contains several vacuoles which ultimately fuse into a single large central one surrounded by a parietal layer of cytoplasm. In the latter are many free nuclei as in other conifers. The development of the cellular tissue from the multinucleate protoplasmic layer seems to closely resemble what has been described in various other conifers and seems to offer no marked peculiarities.

The archegonia in Libocedrus as in Thuja and Juniperus are in a compact group and number from ten to fifteen. There are five or six neck cells and as in other Cupressineae and in Cephalotaxus, the ventral canal cell is represented only by the nucleus, there being no proper ventral canal cell. The whole group of archegonia is surrounded by a layer of jacket cells, but no direct protoplasmic connection could be shown between the latter and the egg cell and it is considered probable that the transfer of food substance takes place through the cell walls.

The actual fertilization was observed in both Thuja and Chamaecyparis and in both cases it was shown that the male nucleus escapes from the cytoplasmic envelope of the male cell, and coming into contact with the egg nucleus, presses into it at one side. Finally the fusion is complete. The fusion nucleus divides until eight free nuclei result, a condition that seems to be universal in the Cupressineae. The organization of the suspensor and embryo proper agrees closely in all forms studied.

Lawson considers the Cupressineae as less primitive than the Abietineae, but more so than Cephalotaxus. Three excellent plates complete the paper.

The Araucariaceae have naturally received less attention than the

more accessible northern coniferous types and there is much need of a critical study of this important family. The important memoir of Professor Seward (The Araucarieae, Recent and Fossil. A. C. Seward, F. R. S. and Sibille O. Ford. *Phil. Trans. Royal Soc.*, series B, vol. 198, pp. 305–411, 1906) is therefore especially welcome.

The Araucariaceae are with few exceptions confined to the southern hemisphere, and although cultivated to a limited extent in the milder portions of Europe and in California they are not readily accessible to most of the students of the conifers and doubtless this largely is responsible for our imperfect knowledge of the more important points in their development.

The genus Agathis (Dammara) is confined to tropical and subtropical regions of Indo-Malaysia and Australasia. The Philippine Islands mark the northern limit of the genus. In the northern island of New Zealand, the home of the famous Kauri pine (*Agathis australis*) the latter species is said to extend to 38° S. Except for *A. robusta* of Queensland and some species from the Malay peninsula, the species of Agathis are essentially island types.

Full diagnoses are given of the species, of which eight are recognized in Agathis and eleven in Araucaria. Several doubtful species are also described. A full account is given of the anatomy of the genera and there is also included an account of the seedlings of several species of Araucaria.

Araucaria is confined entirely to the southern hemisphere, but while most of the species occur in the Australasian region, no less than five belonging to New Caledonia, there are two very distinct species in South America, *A. imbricata*, in Chile and *A. braziliensis* in Brazil. As the Araucariaceae are for the most part trees of warm, moist climates, it is not surprising that growth rings are very feebly marked or may be entirely absent. It is interesting to note, however, that Seward found in the trees of *A. imbricata* grown in England, well marked annual growth rings. The strobili, both male and female, especially in Araucaria, show very gradual transitions from the foliage leaves to the sporophylls. This seems to strengthen the view that both male and female sporophylls are directly homologous with the foliage leaves and this is the view that Seward accepts.

The male flowers of Araucaria are noticeable for their relatively large size, much exceeding that of the other conifers. The number of pollen sacs is large. These sporophylls of *A. imbricata* are 1.9 centimeters in length and may have as many as nineteen sporangia. The sporophylls of the large female cones bear a single very large seed,

which in Agathis is provided with a single wing. In Araucaria the scale develops a ligulate appendage and the ovule is imbedded in the tissue.

The ovule and embryo were only casually studied and not much is added to what we knew before in regard to these.

The fossil Araucariaceae are perhaps of even more interest than the living ones. While there is some doubt of the occurrence of true Araucariaceae in Paleozoic rocks, it is not unlikely that they already existed during the Paleozoic. In the Mesozoic they were abundant and widely distributed. Seward does not agree with those botanists who would regard the Abietineae as perhaps the oldest existing members of the Coniferae. Of Paleozoic fossils not improbably of Araucarian affinity, the genus Walchia shows the closest resemblance to the living forms. In the Jurassic there are fossils which seem to be beyond question true Araucariaceae. Such for example is *Araucarites phillipsii*, and Seward concludes that the Jurassic flora of the northern hemisphere was rich in Araucarian conifers. All of the fossil forms resemble Araucaria rather than Agathis, which is as yet unknown certainly to occur in a fossil state, although numerous fossils have been referred to the genus.

Professor Seward's conclusions as to the affinities of the Araucariaceae and by implication of the other conifers have been strongly opposed, but we believe that his conclusions will be found to be correct. He says: "We have endeavored to show that the Araucarian type is one of the oldest, if not the oldest, of the Coniferales. .... If we have evidence that the Araucariaceae are older than Abietineae, we may reasonably expect to find that the morphological characters of the older group are simpler and less specialized than those of the new group."

Seward also defends a view that we have long maintained, that there is strong reason to believe that the resemblances between the lycopods and conifers are real evidences of relationships, particularly emphasizing the resemblance between the Paleozoic Lepidocarpon and the Araucariaceae. While he recognizes the many differences in structural details between the lycopods and Araucariaceae, he does not believe that these are so great as to forbid the assumption of a lycopodineous origin for the Araucariaceae. We fully endorse his criticism of the extreme view taken by the majority of students of gymnosperms at the present time. He says, "We are disposed to think that the proof of the relationships between cycads and ferns has been allowed an undue influence in opinion regarding the ancestry of the conifers."

Of recent papers on the Gnetaceae, the present paper by Pearson on Welwitschia (Some Observations on Welwitschia mirabilis, Hooker H. H. W. Pearson, M. A., F. L. S. *Phil. Trans. Royal Soc. London*, Series B. Vol. 198, pp. 265–304. Plates 18–22. 1906.) is easily first in point of importance.

One of the most remarkable of known plants is *W. mirabilis*, which is an inhabitant of the desert strip along the coast of Portuguese and German West Africa. In January, 1904, Professor H. H. W. Pearson of the South African College in Cape Town made a visit to Walfisch Bay for the purpose of studying and collecting Welwitschia and the present memoir is a record of his observations. Owing to a native uprising his visit was cut short, and the amount of material collected was limited, but nevertheless a number of important facts were established, which add materially to our knowledge of this extraordinary plant.

The region where it grows is an almost absolutely rainless desert, and excepting at very long intervals the only source of water is the heavy sea fog, whose condensed moisture is sufficient to sustain life in a few plants. It appears, however, that in some seasons, often a good many years apart, heavy rains occur and the country may be inundated. Pearson concludes that it is only during these rare periods of heavy rain that the moisture is sufficient to germinate the seeds of Welwitschia, although these are produced freely each season. The plant does not appear to be able to exist outside the fog belt, but Pearson believes that the main source of water supply is deep seated, as is indicated by the very deep tap root of the plant.

The plants are dioecious, the flowering male plants being more conspicuous than the female. Pearson believes that Hooker's statement that pollination takes place while the ovules are still very small is incorrect and that Strasburger was right in stating that pollination does not occur until the integument of the ovule projects above the subtending bract. There is, however, strong evidence that the plant is entomophilous, as the sticky pollen is not adapted to removal by the wind and the flowers are constantly visited by insects. After pollination, fertilization and maturing of the seed seem to go on more rapidly than in any other gymnosperms. On January 13th Pearson found very few pollinated ovules, but he was informed that a month more would be sufficient for the ripening of the seeds. While this statement needs confirmation, it may very well be true, and if so, it is probably an adaptation connected with the desert habit of the plant.

The anther develops three loculi. In addition to the true tapetal

cells there is a breaking down of some of the sporogenous cells — a condition of things not at all uncommon in the sporangia of certain pteridophytes. In general there is pretty close agreement between Ephedra and Welwitschia in the structure of the stamens. The pollen spores possess three nuclei, one of which usually is completely disorganized before the spores are shed. Of these three, this disorganized nucleus presumably represents a sterile prothallial cell, while the others are respectively tube nucleus and generative nucleus. Pearson found a single archesporial cell in the megasporangium. Although some of the stages were wanting, it was concluded that the archesporial cell divides into several cells, of which one becomes the megaspore. While numbers of young embryo sacs with free nuclei were observed, no dividing nuclei were seen. No vacuole was found in the young embryo sac, a condition, by the way, which is quite similar to what obtains in Peperomia.

The upper part of the nucellus becomes more or less disorganized, and as the prothallium grows there is the usual development of cell walls between the free nuclei; but these cells later become multinucleate, presumably by the division of the original nucleus. In the lower part of the sac there may be as many as twelve nuclei, in some of these cells. The number is less in those in the upper portion of the embryo sac. The upper prothallial cells grow out into tubes penetrating the nucellar cap in much the same way that the pollen tube would do. There are several nuclei in each tube, and these are all assumed to be potentially egg cells, but this has not been definitely proven. These tubes are not to be looked upon as archegonia, but each nucleus is considered to be an egg cell as in *Gnetumgnemon* and the peculiar tube is a special adaptation which is perhaps homologous with the whole apex of the prothallium of Gnetum, with which genus Pearson seems inclined to connect Welwitschia, although of course the relationship is rather a remote one. It is understood that Professor Pearson has been engaged in further studies on this most interesting plant and the result of these studies will be looked forward to with much interest by all students of the gymnosperms.

DOUGLAS HOUGHTON CAMPBELL.

Xerophily of the Gymnosperms.— Although the foliage of the conifers apparently presents adaptations to conditions of drought, Stopes (New Phytologist, 6: 46–50. 1907) finds that at the present time the conifers occupy territory in which the rainfall is, in the main, plentiful. The generally accepted explanation of the occurrence of

characters adapted to drought in environments in which they are unnecessary is that the present day plants have inherited these features from ancestral forms which grew under xerophytic conditions.[1] Miss Stopes, however, argues that in the conifers the xerophytic character is not to be regarded as an inherited adaptation but as correlated with the peculiarities of the conducting system of the stem. The gymnosperms have a much more primitive wood structure than the angiosperms and a much lower capacity for the conduction of water. It is this lower efficiency as conductors of water that necessitates the xerophytic character of the foliage,— not the environment. In other words, the author regards the xerophily of this group as phylogenetic, not adaptive.

With Miss Stope's general conclusion that the xerophily of the Coniferales is phylogenetic and not ecological, Moss agrees (New Phytologist 6 : 183–185. 1906),[2] but he feels that there is an untenable assumption running through the whole of her argument. This assumption is that the conifers in question are more pronounced xerophytes than the angiosperms with which they are ecologically associated. The xerophily of the gymnosperms is seen in the greatly reduced surface of the acicular leaf, whereas that of the angiosperms takes the form of a deciduous habit by which the transpiration is reduced to practically zero during the season of physiological dryness of the soil. He finds that in many instances deciduous angiospermous trees which are commonly regarded as mesophytes, extend into higher altitudes and latitudes than conifers which are generally classed as fine examples of xerophytes. Furthermore, he finds that among both conifers and dicotyledons, the deciduous species are the ones which extend the farthest north.

In view of these facts Moss would consider that the xerophily of the

[1] Clements (Res. Meth. Ecol. 127, 1905) has suggested that the xerophytic characters of bog plants are not due to the "physiological dryness" of their substratum as proposed by Schimper and generally accepted, but to the inheritance of characters acquired when their ancestors were growing in xerophytic environments. He would therefore suggest the origin of stable adaptive structures which persist when the forms which had acquired them are subjected to ecological conditions of the most diverse type.

[2] Moss writes: "With her general contention, that the xerophily of the Coniferales is inherited and not acquired, I do not propose to deal, as Miss Stopes amply proves her case." The sentence is somewhat confusing, but by "inherited" he evidently means phylogenetic in the sense in which Miss Stopes uses the term while "acquired" is equivalent to her "ecological" or "inherited."

conifers is in no wise out of place in the environment of our mesophytic forests, for these are ecologically xerophytic for over half the year. He also holds that in the acicular leaf and the deciduous habit of some of the northern conifers we have more recent adaptations to the demands of a xerophytic habitat, thus accounting for the present wide distribution of this primitive group and its successful competition with phylogenetically higher forms.

The arguments of both of these writers are suggestive, and much of the value of such discussions lies in the emphasis which they lay upon the necessity of approaching these problems with more precise methods than have hitherto been employed.

J. Arthur Harris

Notes on the Problem of Adaptation.— *The Stinging Property of the Giant Nettle tree.* The giant nettle tree, *Laportea gigas*, a native of Australia often attaining a height of over a hundred feet, has long been noted for the violence of its action. Its large juicy leaves are covered with numerous strong hairs or bristles which are filled with a powerful stinging fluid. If the leaves be lightly brushed these hairs penetrate and break in the skin, causing pain which gradually increases in severity and sometimes lasts for several days. A popular name for the Laportea is "mad tree." Petrie (Proc. Linn. Soc. N. S. W., 31: 530–545. 1906) presents a detailed account of the chemical composition and physiological action of the juices of this tree. He suggests five functions for the organic acids which are found in especial abundance, and states that "after considering the various functions in which organic acids take part, we cannot believe that the function of protection is the only one in this case."

Assimilatory Tissue in Mangrove Seedlings. Schimper was inclined to doubt the assimilatory function of the hypocotyl of mangrove seedlings but Goebel and Haberlandt acknowledge that they may perform this function. Carson (New. Phytologist, 6:178–183. 1907) describes the structure of the chlorophyll-containing tissue of the hypocotyl of Bruguiera and Rhizophora, and thinks it safe to assume that in the Rhizophoraceae generally the "hypocotyl is an assimilatory organ and is definitely modified for assimilatory purposes."

Benzoic Acid in Pinguilica. Insects which die in great numbers on the leaves of *Pinguilica vulgaris* emit no putrid odor. Experiments performed by Loew several years ago indicated the presence of some antiseptic substance. Loew and Asō (Bull. Coll. Agric. Imp. Univ.

Tokyo, 7: 411–412. 1907; also Bot. Mag. Tokyo, 21:107–109. 1907) conclude that benzoic acid is the substance which prevents putrefaction. Thus Pinguilica differs from Utricularia in which the captured organisms putrify.

Biologists are much less inclined than formerly to attribute adaptive significance to the characters separating closely related species. Nevertheless Focke (Abh. Naturw. Ver. Bremen, 19:82. 1907) holds that closely related forms are adapted to slightly different habitats. He gives a list of several plant species which he thinks illustrates this point.

Davidson (Agric. Journ. Cape Good Hope, 31:175–177. 1907) calls the attention of botanists to the interesting structural peculiarities of the tuberous Liliaceous genus Eriospermum.

J. A. H.

Plant Cultivation in Art and Education.[1]— During the past few years there has been unusual interest in the possibilities of artistic gardening, both in the country and the city. This is evidenced by the publication of such elegant magazines as the *Country Calender, Suburban Life, Country Life in America,* and the *Garden Magazine,* as well as by the attention which civic leagues everywhere are giving to parks and highways. Many of the publications of the park commissioners of our cities are prepared and published with the most fastidious care, and in them plant cultivation has a prominent place.

The English are still much in advance of Americans in these matters — in interest, theory, and practice. During the last few weeks we note the publication of such works as Kingsley's "Eversley Garden and Others," Thonger's "Book of Rock and Water Gardens," Davidson's "Unheated Greenhouse," and the more pretentious "Art and Craft of Garden Making" by Mawson. On this side of the water

[1] Kingsley, Rose G. Eversley Garden and Others. London. George Allen. 1907. 6 s.

Thonger, C. The Book of Rock and Water Gardens. London & New York. John Lane. 1907. $1.00.

Davidson, K. L. The Unheated Greenhouse. London. The Country Life Co. 1907. 8 s, 6 d.

Mawson, T. H. The Art and Craft of Garden Making. 3 ed. London. B. T. Botsford. 1907.

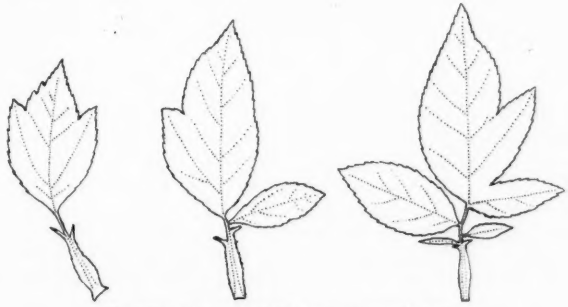
Bisset, P. The Book of Water Gardening. New York. A. T. De La Mare. 1907.

we may record Bissett's "Book of Water Gardening." This is not the place to discuss the merits of these volumes as practical guides or as teachers of art, but in all of them the skill of the photographer has been fully utilized in supplying illustrations, and these the systematic botanist may find of considerable interest. Another finely illustrated work is Perrédès's "London Botanic Gardens," recently reprinted in book form.

The interest in these matters is further evidenced by Baker's discussion of the problems of horticultural education (Journ. Roy. Hort. Soc., 22:152–162. 1907); True's consideration of the advisability of the introduction of elementary agriculture into schools (Yearb. U. S. Dep. Agric., 1906:151–154. 1907); and Cook's arguments in favor of agriculture as the basis of education (Monist, 17:347–364. 1907).

J. Arthur Harris.

Lobed Terminal Leaflets in the Rose.— In discussing the development of pinnate leaves the writer stated that lobed terminal leaflets were not found in the rose. It seemed probable that they would appear, since they occur in the related agrimony, but among twenty-seven hundred leaves of the wild *Rosa lucida* not a single example was found.



Leaves of the cultivated rose. ¾ natural size.

The writer is indebted to Miss Margaret W. Whitney of Pasadena, California, for the lobed leaves of the cultivated rose shown in the accompanying drawing. They indicate that the basifugal tendency is present in the stipular type of basipetal leaves, and that it may predominate.

F. T. Lewis.

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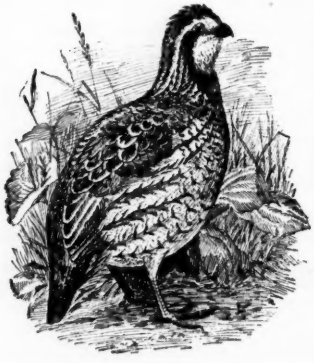

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